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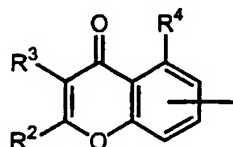
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- (71) Applicant (for all designated States except US): INDENA S.P.A. [IT/IT]; Via Ordes, 12, I-20139 Milano (IT).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): BOMBARDELLI, Ezio [IT/IT]; Via Val di Sole, 22, I-20141 Milano (IT). VALENTI, Piero [IT/IT]; Viale Lenin, 55, I-40139 Bologna (IT).
- (74) Agents: RITTER, Stephen, David et al.; Mathys & Squire, 100 Gray's Inn Road, London WC1X 8AL (GB).
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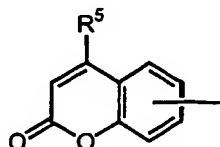
(54) Title: NOVEL DERIVATIVES OF FLAVONES, XANTHONES AND COUMARINS



(I)



(IA)



(IB)

(57) Abstract: Disclosed are novel compounds having the Formula (I):  $Z-OCH_2-C \equiv CCH_2NRR^1$  or a pharmaceutically acceptable salt or solvate thereof wherein Z can represent Formulae (IA) or (IB). The compounds possess antiproliferative activity, and are useful as modulators of multiple drug resistance in cancer chemotherapy. The compounds may also be useful for the manufacture of a medicament for the treatment or prevention of neoplasms, menopausal disorders and osteoporosis.

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### NOVEL DERIVATIVES OF FLAVONES, XANTHONES AND COUMARINS

The development of multiple drug resistance represents an increasing problem in cancer treatment. Within the past decade several mechanisms of drug resistance of tumor cells have been identified. One type of multiple resistance (MDR) has been shown to be mediated by an energy dependent, membrane-bound efflux pump termed P-glycoprotein (PGP) (Biochem. Biophys. Acta, 455, 152, 1976). PGP represents a member of the ATP-binding cassette with low substrate specificity (Nature, 323, 448, 1986). A broad range of cytostatic drugs such as anthracyclines, epipodophyllotoxins, actinomycin D, vinca alkaloids, colchicines and taxol are eliminated via PGP-mediated efflux. Within the past few years a variety of substances have been shown to inhibit PGP-mediated drug efflux and thereby re-establish sensitivity toward chemotherapeutic agents (Pharmacol. Rev. 42, 155, 1990). These include ion channel blockers such as verapamil (Cancer Res 41, 1967, 1981), amiodarone (Cancer Res 46, 825, 1986), propafenone (Proc. Am. Assoc. Cancer Res. 34, 321, 1993), dihydropyridines (Cancer Res. 43, 2267, 1983) phenothiazines (Mol. Pharmacol 35, 105, 1989). Preliminary results obtained in clinical studies clearly demonstrate that modulation of MDR might be a successful approach in haematological malignancies, but serious side effects (cardiac effects, immuno-suppression and nephrotoxicity) often preclude optimal dosage of modulators (Cancer 72, 3553, 1993). Therefore, specifically designed highly active modulators with limited side effects are urgently required.

The present invention relates to a novel class of compounds which have structures related to certain naturally occurring and synthetic flavonoids and to pharmaceutical uses thereof.

Thus according to one aspect of the present invention, there is provided a compound of Formula (I):



(I)

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or a pharmaceutically acceptable salt or solvate thereof wherein:

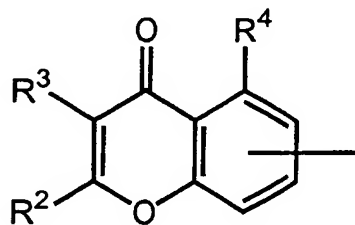
R and R<sup>1</sup> are the same or different and each represents

lower C<sub>1-6</sub> alkyl, or a carbocyclic group containing from 5 to 10 ring atoms,  
said ring atoms forming one or two rings wherein the or each ring contains 5  
or 6 ring atoms, or

R and R<sup>1</sup> taken together with the nitrogen atom to which they are attached, form a  
four- to eight-membered heterocyclic ring which may contain one or more additional  
heteroatoms selected from N, O or S, said heterocyclic ring being optionally  
substituted with a lower C<sub>1-4</sub> alkyl group or a benzyl group;

Z represents:

(A)



wherein

R<sup>2</sup> and R<sup>3</sup> are each independently selected from:

(i) hydrogen, (ii) a substituted or unsubstituted, preferably aromatic,  
carbocyclic or heterocyclic group containing from 5 to 10 ring atoms,  
said ring atoms forming one or two rings, wherein the or each ring  
contains 5 or 6 ring atoms, any heteroatoms being selected from N, O  
and S, any substituents being independently selected from the group  
consisting of:

(a) Cl, (b) Br, (c) F, (d) OH, (e) NO<sub>2</sub>, (f) CF<sub>3</sub>, (g) C<sub>1-4</sub> lower alkyl  
(in particular CH<sub>3</sub>), (h) SCH<sub>3</sub>, (i) NHCOCH<sub>3</sub>, (j) N(R<sup>6</sup>)(R<sup>8</sup>)  
wherein R<sup>6</sup> and R<sup>8</sup>, are the same or different and each  
represents H or lower C<sub>1-4</sub> alkyl, (k) OR<sup>10</sup> wherein R<sup>10</sup> represents  
H or lower C<sub>1-6</sub> alkyl which may be saturated or unsaturated and  
being unsubstituted or substituted with the group NRR<sup>1</sup> wherein  
R and R<sup>1</sup> is as defined above, and (l) OCOR<sup>11</sup> wherein R<sup>11</sup>  
represents H or lower C<sub>1-4</sub> alkyl.

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(iii) Cl, (iv) Br, (v) F, (vi) OH, (vii) NO<sub>2</sub>, (viii) a saturated or unsaturated lower C<sub>1-6</sub> straight or branched hydrocarbyl group which may be unsubstituted or substituted by 1, 2 or 3 substituents selected from Cl, Br, F, OMe, NO<sub>2</sub> and CF<sub>3</sub>, (ix) NHCOCH<sub>3</sub>, (x) N(R<sup>6</sup>)(R<sup>8</sup>), (xi) SR<sup>10</sup>, (xii) OR<sup>10</sup>, and (xiii) OCOR<sup>11</sup> wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are as defined above;

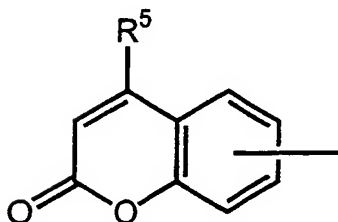
or

R<sub>2</sub> and R<sub>3</sub> taken together with the carbon atoms to which they are attached form a carbocyclic or heterocyclic ring having 5 or 6 ring atoms, any heteroatom being selected from N, O or S, said carbocyclic or heterocyclic ring being saturated or unsaturated, and being unsubstituted or substituted with one or more substituents selected from Cl, Br, F, OH, NO<sub>2</sub>, CF<sub>3</sub>, C<sub>1-4</sub> lower alkyl, SCH<sub>3</sub>, NHCOCH<sub>3</sub>, N(R<sup>6</sup>)(R<sup>8</sup>), OR<sup>10</sup> and OCOR<sup>11</sup> wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are as defined above; and

R<sup>4</sup> represents hydrogen, or OR<sup>10</sup> wherein R<sup>10</sup> is as defined above

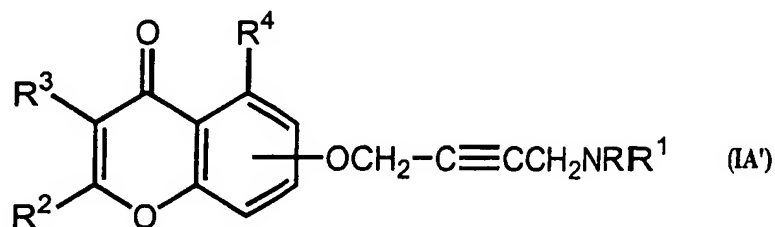
or

(B)



wherein R<sup>5</sup> represents hydrogen or a lower C<sub>1-6</sub> straight or branched hydrocarbyl group which may be unsubstituted or substituted by 1, 2 or 3 substituents selected from Cl, Br, F, OMe, NO<sub>2</sub> and CF<sub>3</sub>.

Thus in one aspect the invention provides compounds having the structure (IA'):



wherein

$R^2$  and  $R^3$  are each independently selected from:

- 5 (i) hydrogen, (ii) a substituted or unsubstituted, preferably aromatic, carbocyclic or heterocyclic group containing from 5 to 10 ring atoms, said ring atoms forming one or two rings, wherein the or each ring contains 5 or 6 ring atoms, any heteroatoms being selected from N, O and S, any substituents being independently selected from the group consisting of:

10 Cl, Br, F, OH,  $\text{NO}_2$ ,  $\text{CF}_3$ ,  $\text{C}_{1-4}$  lower alkyl (in particular  $\text{CH}_3$ ),  $\text{SCH}_3$ ,  $\text{NHCOCH}_3$ ,  $\text{N}(\text{R}^6)(\text{R}^8)$ ,  $\text{OR}^{10}$  and  $\text{OCOR}^{11}$ , wherein  $\text{R}^6$ ,  $\text{R}^8$ ,  $\text{R}^{10}$  and  $\text{R}^{11}$  are the same or different and each represents H or lower  $\text{C}_{1-4}$  alkyl,

(iii) Cl, (iv) Br, (v) F, (vi) OH, (vii)  $\text{NO}_2$ , (viii) a saturated or unsaturated lower  $\text{C}_{1-6}$  straight or branched hydrocarbyl group which may be unsubstituted or substituted by 1, 2 or 3 substituents selected from Cl, Br, F, OMe,  $\text{NO}_2$  and  $\text{CF}_3$ , (ix)  $\text{NHCOCH}_3$ , (x)  $\text{N}(\text{R}^6)(\text{R}^8)$ , (xi)  $\text{SR}^{10}$ , (xii)  $\text{OR}^{10}$ , and (xiii)  $\text{OCOR}^{11}$  wherein  $\text{R}^6$ ,  $\text{R}^8$ ,  $\text{R}^{10}$  and  $\text{R}^{11}$  are as defined above;

or

20  $\text{R}_2$  and  $\text{R}_3$  taken together with the carbon atoms to which they are attached form a carbocyclic or heterocyclic ring having 5 or 6 ring atoms, any heteroatom being selected from N, O or S, said carbocyclic or heterocyclic ring being saturated or unsaturated, and being unsubstituted or substituted with one or more substituents selected from Cl, Br, F, OH,  $\text{NO}_2$ ,  $\text{CF}_3$ ,  $\text{C}_{1-4}$  lower alkyl,  $\text{SCH}_3$ ,  $\text{NHCOCH}_3$ ,  $\text{N}(\text{R}^6)(\text{R}^8)$ ,  $\text{OR}^{10}$  and  $\text{OCOR}^{11}$ , wherein  $\text{R}^6$ ,  $\text{R}^8$ ,  $\text{R}^{10}$  and  $\text{R}^{11}$  are as defined above; and

25  $\text{R}^4$  represents hydrogen, or  $\text{OR}^{10}$  wherein  $\text{R}^{10}$  is as defined above.

## 5

A preferred group of compounds are those wherein R, R<sup>1</sup> and R<sup>4</sup> are as defined for Formula (IA') above, and

R<sup>2</sup> and R<sup>3</sup> are each independently selected from:

- 5 (i) hydrogen, (ii) a substituted or unsubstituted, preferably aromatic, carbocyclic or heterocyclic group containing from 5 to 10 ring atoms, said ring atoms forming one or two rings, wherein the or each ring contains 5 or 6 ring atoms, any heteroatoms being selected from N, O and S, any substituents being independently selected from the group consisting of:
- 10 (a) Cl, (b) Br, (c) F, (d) OH, (e) NO<sub>2</sub>, (f) CF<sub>3</sub>, (g) C<sub>1-4</sub> lower alkyl (in particular CH<sub>3</sub>), (h) SCH<sub>3</sub>, (i) NHCOCH<sub>3</sub>, (j) N(R<sup>6</sup>)(R<sup>8</sup>) wherein R<sup>6</sup> and R<sup>8</sup> are the same or different and each represents H or lower C<sub>1-4</sub> alkyl, (k) OR<sup>10</sup> wherein R<sup>10</sup> represents H or lower C<sub>1-6</sub> alkyl which may be saturated or unsaturated and being unsubstituted or substituted with the group NRR<sup>1</sup> wherein R and R<sup>1</sup> is as defined above, and (l) OCOR<sup>11</sup>
- 15 wherein R<sup>11</sup> represents H or lower C<sub>1-4</sub> alkyl,
- (iii) Cl, (iv) Br, (v) F, (vi) OH, (vii) NO<sub>2</sub>, (viii) a saturated or unsaturated lower C<sub>1-6</sub> straight or branched hydrocarbyl group which may be unsubstituted or substituted by 1, 2 or 3 substituents selected from Cl, Br, F, OMe, NO<sub>2</sub> and CF<sub>3</sub>, (ix) NHCOCH<sub>3</sub>, (x) N(R<sup>6</sup>)(R<sup>8</sup>), (xi) SR<sup>10</sup>, (xii) OR<sup>10</sup>, and (xiii) OCOR<sup>11</sup>
- 20 wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are as defined for Formula (I).

Within this group, R<sup>2</sup> and R<sup>3</sup> can both represent hydrogen. A further preferred group of compounds are those wherein one of R<sup>1</sup> or R<sup>2</sup> is hydrogen, and the other is selected from the group consisting of: (i) a substituted or unsubstituted, preferably

25 aromatic, carbocyclic or heterocyclic group containing from 5 to 10 ring atoms, said ring atoms forming one or two rings, wherein the or each ring contains 5 or 6 ring atoms, any heteroatoms being selected from N, O and S, any substituents being independently selected from the group consisting of:

- 30 Cl, Br, F, OH, NO<sub>2</sub>, CF<sub>3</sub>, C<sub>1-4</sub> lower alkyl (in particular CH<sub>3</sub>), SCH<sub>3</sub>, NHCOCH<sub>3</sub>, N(R<sup>6</sup>)(R<sup>8</sup>), OR<sup>10</sup> and OCOR<sup>11</sup>, wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are the same or different and each represents H or lower C<sub>1-4</sub> alkyl,
- (ii) Cl, (iii) Br, (iv) F, (v) OH, (vi) NO<sub>2</sub>, (vii) a saturated or unsaturated lower C<sub>1-6</sub> straight or branched hydrocarbyl group which may be unsubstituted or substituted by

1, 2 or 3 substituents selected from Cl, Br, F, OMe, NO<sub>2</sub> and CF<sub>3</sub>, (viii) NHCOCH<sub>3</sub>, (ix) N(R<sup>6</sup>)(R<sup>8</sup>), (x) SR<sup>10</sup>, (xi) OR<sup>10</sup>, and (xii) OCOR<sup>11</sup> wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are as defined for Formula (I).

- 5 Within this preferred group of compounds, a further preferred group of compounds are those wherein R<sup>2</sup> hydrogen and R<sup>3</sup> is selected from the group consisting of: (i) a substituted or unsubstituted, preferably aromatic, carbocyclic or heterocyclic group containing from 5 to 10 ring atoms, said ring atoms forming one or two rings, wherein the or each ring contains 5 or 6 ring atoms, any heteroatoms being selected from N,  
 10 O and S, any substituents being independently selected from the group consisting of:  
 Cl, Br, F, OH, NO<sub>2</sub>, CF<sub>3</sub>, C<sub>1-4</sub> lower alkyl (in particular CH<sub>3</sub>), SCH<sub>3</sub>, NHCOCH<sub>3</sub>, N(R<sup>6</sup>)(R<sup>8</sup>), OR<sup>10</sup> and OCOR<sup>11</sup>, wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are the same or different and each represents H or lower C<sub>1-4</sub> alkyl,  
 (ii) Cl, (iii) Br, (iv) F, (v) OH, (vi) NO<sub>2</sub>, (vii) a saturated or unsaturated lower C<sub>1-6</sub>  
 15 straight or branched hydrocarbonyl group which may be unsubstituted or substituted by 1, 2 or 3 substituents selected from Cl, Br, F, OMe, NO<sub>2</sub> and CF<sub>3</sub>, (viii) NHCOCH<sub>3</sub>, (ix) N(R<sup>6</sup>)(R<sup>8</sup>), (x) SR<sup>10</sup>, (xi) OR<sup>10</sup>, and (xii) OCOR<sup>11</sup> wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are as defined for Formula (I).
- 20 A further preferred group of compounds are those wherein R<sup>3</sup> is hydrogen and R<sup>2</sup> is selected from the group consisting of: (i) a substituted or unsubstituted, preferably aromatic, carbocyclic or heterocyclic group containing from 5 to 10 ring atoms, said ring atoms forming one or two rings, wherein the or each ring contains 5 or 6 ring atoms, any heteroatoms being selected from N, O and S, any substituents being  
 25 independently selected from the group consisting of:  
 Cl, Br, F, OH, NO<sub>2</sub>, CF<sub>3</sub>, C<sub>1-4</sub> lower alkyl (in particular CH<sub>3</sub>), SCH<sub>3</sub>, NHCOCH<sub>3</sub>, N(R<sup>6</sup>)(R<sup>8</sup>), OR<sup>10</sup> and OCOR<sup>11</sup>, wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are the same or different and each represents H or lower C<sub>1-4</sub> alkyl,  
 (ii) Cl, (iii) Br, (iv) F, (v) OH, (vi) NO<sub>2</sub>, (vii) a saturated or unsaturated lower C<sub>1-6</sub>  
 30 straight or branched hydrocarbonyl group which may be unsubstituted or substituted by 1, 2 or 3 substituents selected from Cl, Br, F, OMe, NO<sub>2</sub> and CF<sub>3</sub>, (viii) NHCOCH<sub>3</sub>, (ix) N(R<sup>6</sup>)(R<sup>8</sup>), (x) SR<sup>10</sup>, (xi) OR<sup>10</sup>, and (xii) OCOR<sup>11</sup> wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are as defined for Formula (I).

A further preferred embodiment of the present invention are compounds wherein  $R^2$  represents a substituted or unsubstituted, preferably aromatic, carbocyclic or heterocyclic group containing from 5 to 10 ring atoms, said ring atoms forming one or two rings, wherein the or each ring contains 5 or 6 ring atoms, any heteroatoms being selected from N, O and S, any substituents being independently selected from the group consisting of: Cl, Br, F, OH,  $\text{NO}_2$ ,  $\text{CF}_3$ ,  $\text{C}_{1-4}$  lower alkyl (in particular  $\text{CH}_3$ ),  $\text{SCH}_3$ ,  $\text{NHCOCH}_3$ ,  $\text{N}(\text{R}^6)(\text{R}^8)$ ,  $\text{OR}^{10}$  and  $\text{OCOR}^{11}$ , wherein  $\text{R}^6$ ,  $\text{R}^8$ ,  $\text{R}^{10}$  and  $\text{R}^{11}$  are as defined as for Formula (I). For these compounds,  $\text{R}^3$  is preferably selected from the group consisting of H, Cl, Br, F, OH,  $\text{NO}_2$ , a saturated or unsaturated lower  $\text{C}_{1-6}$  straight or branched hydrocarbyl group which may be unsubstituted or substituted by 1, 2 or 3 substituents selected from Cl, Br, F, OMe,  $\text{NO}_2$  and  $\text{CF}_3$ ,  $\text{NHCOCH}_3$ ,  $\text{N}(\text{R}^6)(\text{R}^8)$ ,  $\text{SR}^{10}$ ,  $\text{OR}^{10}$ , and  $\text{OCOR}^{11}$  wherein  $\text{R}^6$ ,  $\text{R}^8$ ,  $\text{R}^{10}$  and  $\text{R}^{11}$  are as defined for Formula (I).

Alternatively compound  $\text{R}^3$  may represent a substituted or unsubstituted, preferably aromatic, carbocyclic or heterocyclic group containing from 5 to 10 ring atoms, said ring atoms forming one or two rings, wherein the or each ring contains 5 or 6 ring atoms, any heteroatoms being selected from N, O and S, any substituents being independently selected from the group consisting of:

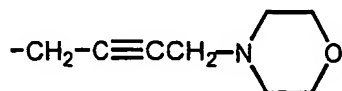
Cl, Br, F, OH,  $\text{NO}_2$ ,  $\text{CF}_3$ ,  $\text{C}_{1-4}$  lower alkyl (in particular  $\text{CH}_3$ ),  $\text{SCH}_3$ ,  $\text{NHCOCH}_3$ ,  $\text{N}(\text{R}^6)(\text{R}^8)$ ,  $\text{OR}^{10}$  and  $\text{OCOR}^{11}$ , wherein  $\text{R}^6$ ,  $\text{R}^8$ ,  $\text{R}^{10}$  and  $\text{R}^{11}$  are as defined for Formula (I).

For these compounds,  $\text{R}^2$  is preferably selected from the group consisting of H, Cl, Br, F, OH,  $\text{NO}_2$ , a saturated or unsaturated lower  $\text{C}_{1-6}$  straight or branched hydrocarbyl group which may be unsubstituted or substituted by 1, 2 or 3 substituents selected from

Cl, Br, F, OMe,  $\text{NO}_2$  and  $\text{CF}_3$ ,  $\text{NHCOCH}_3$ ,  $\text{N}(\text{R}^6)(\text{R}^8)$ ,  $\text{SR}^{10}$ ,  $\text{OR}^{10}$ , and  $\text{OCOR}^{11}$  wherein  $\text{R}^6$ ,  $\text{R}^8$ ,  $\text{R}^{10}$  and  $\text{R}^{11}$  are as defined for Formula (I).

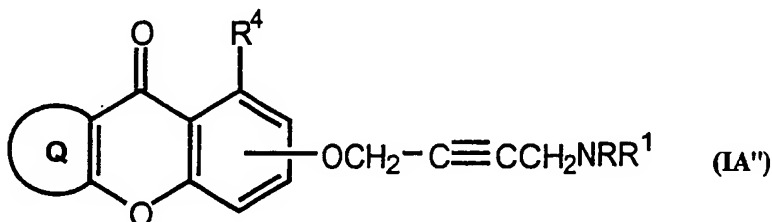
Where  $R^2$  and/or  $R^3$  represents a substituted carbocyclic or heterocyclic group, the substituents on the carbocyclic or heterocyclic group are preferably selected from OH or  $OR^{10}$  wherein  $R^{10}$  is as defined for Formula (I).

- 5 A particularly preferred carbocyclic group is phenyl or phenyl substituted with 1 to 3 OH or  $OR^{10}$  groups. For these compounds,  $R^{10}$  preferably represents methyl or



- Also preferred are compounds wherein one of  $R^2$  or  $R^3$  represents H or a lower  $C_{1-6}$  straight or branched hydrocarbyl group, with methyl being especially preferred.

The invention also provides a compound of Formula (I) having the structure (IA''):

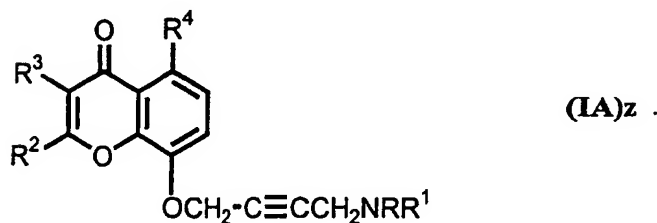
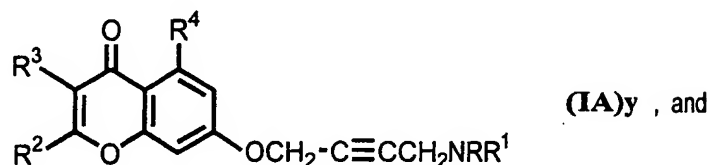
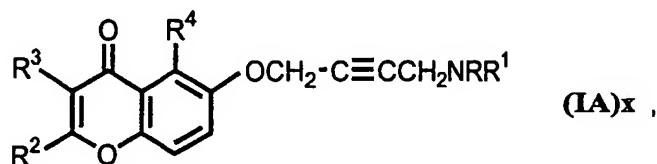


- wherein R,  $R^1$  and  $R^4$  are as defined as for Formula (I), and  $R^2$  and  $R^3$  taken together represent Ring Q, said Ring Q being a carbocyclic or heterocyclic ring having 5 or 6 ring atoms, any heteroatom being selected from N, O or S, said carbocyclic or heterocyclic ring being saturated or unsaturated and being unsubstituted or substituted with one or more substituents selected from Cl, Br, F, OH,  $\text{NO}_2$ ,  $\text{CF}_3$ ,  $C_{1-4}$  lower alkyl,  $\text{SCH}_3$ ,  $\text{NHCOCH}_3$ ,  $\text{N}(R^6)(R^8)$ ,  $OR^{10}$  and  $OCOR^{11}$ , wherein  $R^6$ ,  $R^8$ ,  $R^{10}$  and  $R^{11}$  are as defined as for Formula (I).

- For these compounds Ring Q preferably represents a carbocyclic or heterocyclic aromatic ring, any heteroatom being selected from N, O or S, said ring being unsubstituted or substituted with one or more substituents selected from Cl, Br, F, OH,  $\text{NO}_2$ ,  $\text{CF}_3$ ,  $C_{1-4}$  lower alkyl,  $\text{SCH}_3$ ,  $\text{NHCOCH}_3$ ,  $\text{N}(R^6)(R^8)$ ,  $OR^{10}$  and  $OCOR^{11}$ ,

wherein  $R^6$ ,  $R^8$ ,  $R^{10}$  and  $R^{11}$  are as defined as in Formula (I). Particularly preferred are those compounds wherein Ring Q represents a benzene or pyridine ring.

5 The substituent Z may be attached to any position in the aromatic ring. Thus the compounds of Formula (IA') or (IA'') described above include compounds having the structures (IA)<sub>x</sub>, (IA)<sub>y</sub> and (IA)<sub>z</sub>:



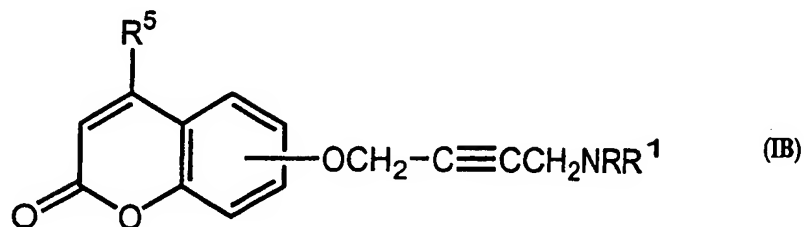
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wherein  $R$ ,  $R^1$ ,  $R^2$ ,  $R^3$  and  $R^4$  are as defined above.

For the compounds of Formula (IA') or (IA'') described above,  $R^4$  preferably represents H, OH or  $OCH_3$ .

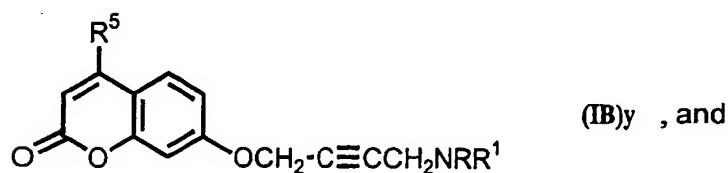
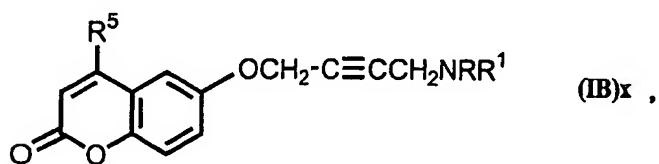
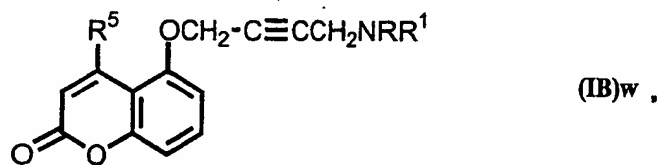
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The invention further provides compounds of Formula (I) having the structure (IB):

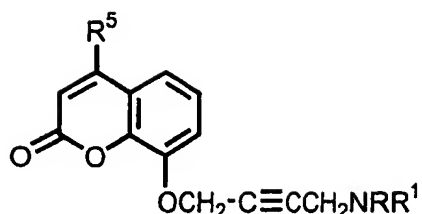


wherein R and R<sup>1</sup> are as defined for Formula (I) and R<sup>5</sup> represents H or a lower C<sub>1-6</sub> straight or branched hydrocarbyl group which may be unsubstituted or substituted by 1, 2 or 3 substituents selected from Cl, Br, F, OMe, NO<sub>2</sub> and CF<sub>3</sub>. In a preferred embodiment, R<sup>5</sup> represents H or methyl.

For the compounds of Formula (IB) described above, the substituent Z may be attached to any position in the aromatic ring. Thus the compounds of Formula (IB) described above include compounds having the structures (IB)<sub>w</sub>, (IB)<sub>x</sub>, (IB)<sub>y</sub> and (IB)<sub>z</sub>:



A4



wherein R, R<sup>1</sup> and R<sup>5</sup> are as defined for Formula (I).

5 For the compounds of Formulae (I), (IA'), (IA'') or (IB), the substituent R and R<sup>1</sup> are the same or different and preferably each represents a C<sub>1-4</sub> alkyl group or a C<sub>5-8</sub> cycloalkyl group. Within this group of compounds, R and R<sup>1</sup> are preferably independently selected from methyl, ethyl, propyl, cyclopropyl or a cyclohexyl group.

10 In a preferred group of compounds, the R and R<sup>1</sup> groups taken together with the nitrogen atom to which they are attached, form a four- to eight-membered heterocyclic ring. Of these, it is preferred that R and R<sup>1</sup> taken together with the nitrogen atom to which they are attached, form a pyrrolidine, piperidine, piperazine, N-methylpiperazine, N-benzylpiperazine or a morpholine group.

15 It will be appreciated that the compounds of Formula (I) contain a basic amino function and thus may be converted to acid addition salts, with pharmacologically acceptable acids, e.g. hydrochloric acid and phosphoric acid. Such salts are also included in the present invention.

20 The compounds of Formula (I) may be conveniently prepared by a process comprising the steps of:

- (i) reacting a hydroxy derivative, Z-OH, with propargyl bromide to form an alkyne, Z-OCH<sub>2</sub>C≡H; and
  - (ii) reacting the alkyne Z-OCH<sub>2</sub>C≡H with an amine HNRR<sup>1</sup>. Such a process
- 25 forms a further aspect of the present invention.

The invention further provides a compound of Formula (I) as defined above for use as a modulator of multiple drug resistance in cancer chemotherapy or an

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antiproliferative medicament. In particular, the compounds of Formula (I) are especially useful for the modulation of multiple drug resistance mediated by P-glycoprotein.

5 The compounds of Formula (I) as defined above may also be useful for the manufacture of a medicament for the treatment or prevention of neoplasms, particularly those located in the uterus, ovary or breast. Further the compounds Formula (I) may be especially useful for the manufacture of a medicament for the treatment of paclitaxel- and docetaxel-resistant cancer cells.

10

The compounds of Formula (I) may also advantageously be used as an antiproliferative medicament in combination therapies involving the combined use of a compound of Formula (I) with one or more anti-neoplastic or cytostatic agents, such as paclitaxel or docetaxel. The combination therapy may involve simultaneous or successive administration of a compound of Formula (I) with one or more antineoplastic or cytostatic agents, including anthracyclines, epipodophyllotoxins, actinomycin D, vinca alkaloids, colchicines, paclitaxel or docetaxel. Such combination therapy forms a further aspect of the invention.

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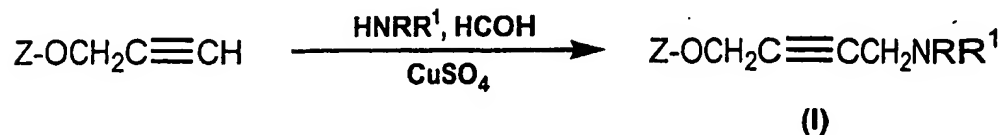
20 The compounds of the invention may also be useful in the manufacture of a medicament for the treatment or prevention of menopausal disorders and osteoporosis.

The invention further provides a pharmaceutical composition comprising one of more of the compounds of Formula (I) in combination with one or more pharmaceutically acceptable excipients. Such a composition may also comprise one or more antineoplastic or cytostatic agents, such as paclitaxel or docetaxel.

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The invention will now be described by way of illustrative examples and with reference to the accompanying formulae drawings.

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**EXAMPLES****Example 1. General conditions to obtain the propynyloxy derivatives**

- 5 A mixture of hydroxy derivative (0.01 mol),  $\text{K}_2\text{CO}_3$  (0.02 mol), KI (0.01 mol), propargyl bromide (0.015 mol) and acetone (100 mL) was refluxed 10 h and hot filtered. The solvent was evaporated and the residue was crystallized with a suitable solvent.

**Example 2. Preparation of 7-propynyloxy-4'-methoxyisoflavone**

- 10 A mixture of 7-hydroxy-4'-methoxyisoflavone (2.68 g, 0.01 mol),  $\text{K}_2\text{CO}_3$  (2.8 g, 0.02 mol), KI (0.166 g, 0.001 mol), propargyl bromide (1.78 g, 0.015 mol) and acetone (100 mL) was refluxed 10 h and hot filtered. The solvent was evaporated and the residue was crystallized by toluene. This yields 2.75 g of a product with the following characteristics: m.p. 145-146°C;  $^1\text{H}$  NMR ( $\text{CDCl}_3$ )  $\delta$ : 2.6 (m, 1H), 3.83 (s, 3H), 4.8 (s, 2H), 6.93-8.27 (m, 8H).
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**Example 3. Preparation of 7-propynyloxyisoflavone**

- A mixture of 7-hydroxyisoflavone (2.38 g, 0.01 mol),  $\text{K}_2\text{CO}_3$  (2.8 g, 0.02 mol), KI (0.166 g, 0.001 mol), propargyl bromide (1.78 g, 0.015 mol) and acetone (100 mL) was refluxed 10 h and hot filtered. The solvent was evaporated and the residue was crystallized by toluene. This yields 2.1 g of a product with the following characteristics: m.p. 130-131°C;  $^1\text{H}$  NMR ( $\text{CDCl}_3$ )  $\delta$ : 2.6 (m, 1H), 4.8 (s, 2H), 6.99-8.28 (m, 7H).
- 20

**Example 4. Preparation of 7-propynyloxy-2-methyl-4'-methoxyisoflavone**

- 25 A mixture of 7-hydroxy-2-methyl-4'-methoxyisoflavone (2.82 g, 0.01 mol),  $\text{K}_2\text{CO}_3$  (2.8 g, 0.02 mol), KI (0.166 g, 0.001 mol), propargyl bromide (1.78 g, 0.015 mol) and acetone (100 mL) was refluxed 10 h and hot filtered. The solvent was evaporated and the residue was crystallized by toluene. This yields 2.24 g of a product with the

following characteristics: m.p. 139-140°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) δ: 2.29 (s, 3H), 2.6 (m, 1H), 3.85 (s, 3H), 4.75 (s, 2H), 6.93-8.17 (m, 7H).

**Example 5. Preparation of 7-propynyloxy-5-hydroxy-4'-methoxyisoflavone**

5 A mixture of 5,7-dihydroxy-4'-methoxyisoflavone (2.84 g, 0.01 mol), K<sub>2</sub>CO<sub>3</sub> (2.8 g, 0.02 mol), KI (0.166 g, 0.001 mol), propargyl bromide (1.78 g, 0.015 mol) and acetone (100 mL) was refluxed 10 h and hot filtered. The solvent was evaporated and the residue was crystallized by toluene. This yields 2.25 g of a product with the following characteristics: m.p. 174-176°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) δ: 2.6 (m, 1H), 3.86 (s, 10 3H), 4.8 (s, 2H), 6.47-7.91 (m, 7H), 12.90 (s, 1H).

**Example 6. Preparation of 7,4'-dipropynyloxyisoflavone**

A mixture of 5,7-dihydroxy-4'-methoxyisoflavone (2.54 g, 0.01 mol), K<sub>2</sub>CO<sub>3</sub> (2.8 g, 0.02 mol), KI (0.166 g, 0.001 mol), propargyl bromide (1.72 g, 0.015 mol) and 15 acetone (100 mL) was refluxed 10 h and hot filtered. The solvent was evaporated and the residue was crystallized by toluene. This yields 2.31 g of a product with the following characteristics: m.p. 162-163°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) δ: 2.44 (m, 1H, CH), 2.57 (m, 1H), 4.54 (s, 2H), 4.56 (s, 2H), 6.85-8.08 (m, 8H).

20 **Example 7. Preparation of 1-propynyloxyxanthen-9-one**

A mixture of 3-hydroxyxanthen-9-one (2.12 g, 0.01 mol), K<sub>2</sub>CO<sub>3</sub> (2.8 g, 0.02 mol), KI (0.166 g, 0.001 mol), propargyl bromide (1.78 g, 0.015 mol) and acetone (100 mL) was refluxed 10 h and hot filtered. The solvent was evaporated and the residue was crystallized by toluene. This yields 2.0 g of a product with the following 25 characteristics: m.p. 168-169°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) δ: 2.56 (m, 1H), 4.94 (s, 2H), 6.95-8.33 (m, 7H).

**Example 8. Preparation of 2-propynyloxyxanthen-9-one**

A mixture of 2-hydroxyxanthen-9-one (2.12 g, 0.01 mol), K<sub>2</sub>CO<sub>3</sub> (2.8 g, 0.02 mol), KI 30 (0.166 g, 0.001 mol), propargyl bromide (1.78 g, 0.015 mol) and acetone (100 mL) was refluxed 10 h and hot filtered. The solvent was evaporated and the residue was crystallized by toluene. This yields 2.25 g of a product with the following

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characteristics: m.p. 153-154°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) δ: 2.58 (m, 1H), 4.8 (s, 2H), 7.35-8.38 (m, 7H).

**Example 9. Preparation of 3-propynyloxyxanthene-9-one**

5 A mixture of 3-hydroxyxanthene-9-one (2.12 g, 0.01 mol), K<sub>2</sub>CO<sub>3</sub> (2.8 g, 0.02 mol), KI (0.166 g, 0.001 mol), propargyl bromide (1.78 g, 0.015 mol) and acetone (100 mL) was refluxed 10 h and hot filtered. The solvent was evaporated and the residue was crystallized by toluene. This yields 2.25 g of a product with the following characteristics: m.p. 142-144°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) δ: 2.61 (m, 1H), 4.84 (s, 2H), 6.98-10 8.38 (m, 7H).

**Example 10. Preparation of 7-propynyloxyflavone**

A mixture of 7-hydroxyflavone (2.38 g, 0.01 mol), K<sub>2</sub>CO<sub>3</sub> (2.8 g, 0.02 mol), KI (0.166 g, 0.001 mol), propargyl bromide (1.78 g, 0.015 mol) and acetone (100 mL) 15 was refluxed 10 h and hot filtered. The solvent was evaporated and the residue was crystallized by toluene. This yields 2.58 g of a product with the following characteristics: m.p. 199-200°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) δ: 2.6 (m, 1H), 4.8 (s, 2H), 6.75-8.18 (m, 9H).

20 **Example 11. Preparation of 7-propynyloxy-3-methylflavone**

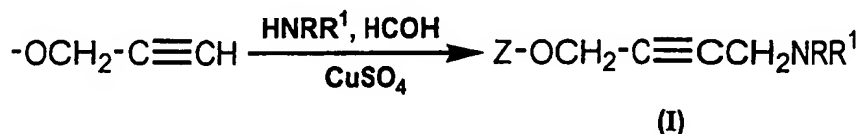
A mixture of 7-hydroxy-3-methylflavone (2.52 g, 0.01 mol), K<sub>2</sub>CO<sub>3</sub> (2.8 g, 0.02 mol), KI (0.166 g, 0.001 mol), propargyl bromide (1.78 g, 0.015 mol) and acetone (100 mL) was refluxed 10 h and hot filtered. The solvent was evaporated and the residue was crystallized by toluene. This yields 2.32 g of a product with the following 25 characteristics: m.p. 179-180°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) δ: 2.15 (s, 3H), 2.69 (m, 1H), 4.8 (s, 2H), 6.95-8.25 (m, 8H).

**Example 12. Preparation of 7-propynyloxy-4-methylcoumarin**

A mixture of 7-hydroxy-4-methylcoumarin (1.76 g, 0.01 mol), K<sub>2</sub>CO<sub>3</sub> (2.8 g, 0.02 mol), KI (0.166 g, 0.001 mol), propargyl bromide (1.78 g, 0.015 mol) and acetone (100 mL) 30 was refluxed 10 h and hot filtered. The solvent was evaporated and the residue was crystallized by toluene. This yields 1.93 g of a product with the following

characteristics: m.p. 140-141°C; <sup>1</sup>H NMR (CDCl<sub>3</sub>) δ: 2.4 (s), 2.69 (m), 4.8 (s, 2H), 6.15-7.58 (m, 4H).

**Example 13. General conditions to obtain the aminopropynyloxy derivatives**



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A solution of formaldehyde (0.5 ml), selected amine (6 mmol) and CuSO<sub>4</sub> (0.1 g) in EtOH/H<sub>2</sub>O (20 mL) was added to a solution of propynyloxy derivative (4.6 mmol) in EtOH/H<sub>2</sub>O (20 mL). H<sub>2</sub>SO<sub>4</sub> was added until pH 8 and the mixture was refluxed 24 h. NH<sub>3</sub> (30 mL) was added and the mixture was extracted with ether. After evaporation  
10 of the solvent the residue was purified by flash-chromatography (eluent: toluene/acetone 4/1) and crystallized by suitable solvent.

**Example 14. 7-(4-Piperidinobut-2-yn)-oxy-4'-methoxyisoflavone (see accompanying formula drawing VIB 15)**

15 A solution of formaldehyde (1 ml), piperidine (0.85 g, 0.01 mol) and CuSO<sub>4</sub> (0.2 g) in EtOH/H<sub>2</sub>O (40 mL) was added to a solution of propynyloxy derivative (3.08 g, 0.01 mol) in EtOH/H<sub>2</sub>O (40 mL). H<sub>2</sub>SO<sub>4</sub> was added until pH 8 and the mixture was refluxed 24 h. NH<sub>3</sub> (60 mL) was added and the mixture was extracted with ether. After evaporation of the solvent the residue was purified by flash-chromatography (eluent:  
20 toluene/acetone 4/1) and crystallized by ligroin. This yields 1.63 g of a product with the following characteristics: m.p. 95-97°C; <sup>1</sup>H NMR δ: 1.73-1.98 (m, 2H), 1.52-1.68, (q, 4H), 2.4-2.55 (t, 4H), 3.3 (s, 2H), 3.85 (s, 3H), 4.85 (s, 2H), 6.9-8.25 (m, 8H).

**Example 15. 7-(4-Morpholinobut-2-yn)-oxy-4'-methoxyisoflavone (see accompanying formula drawing VIB 17)**

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A solution of formaldehyde (1 ml), morpholine (0.87 g, 0.01 mol) and CuSO<sub>4</sub> (0.2 g) in EtOH/H<sub>2</sub>O (40 mL) was added to a solution of propynyloxy derivative (3.08 g, 0.01 mol) in EtOH/H<sub>2</sub>O (40 mL). H<sub>2</sub>SO<sub>4</sub> was added until pH 8 and the mixture was refluxed 24 h. NH<sub>3</sub> (60 mL) was added and the mixture was extracted with ether.

17

After evaporation of the solvent the residue was purified by flash-chromatography (eluent: toluene/acetone 4/1) and crystallized by ligroin. This yields 1.62 g of a product with the following characteristics: m.p. 98-100°C; <sup>1</sup>H NMR δ: 2.43-2.61 (m, 4H), 3.3 (s, 2H), 3.6-3.78 (m, 4H), 3.78 (s, 3H), 4.75 (s, 2H), 6.9-8.3 (m, 8H).

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**Example 16. 7-[4-(4-Benzyl-piperazin-1-yl)-but-2-yn]-oxy-4'-methoxyisoflavone**  
(see accompanying formula drawing VIB 16)

A solution of formaldehyde (1 ml), benzylpiperazine (1.76 g, 0.01 mol) and CuSO<sub>4</sub> (0.2 g) in EtOH/H<sub>2</sub>O (40 ml) was added to a solution of propynyloxy derivative (3.08 g, 0.01 mol) in EtOH/H<sub>2</sub>O (40 mL). H<sub>2</sub>SO<sub>4</sub> was added until pH 8 and the mixture was refluxed 24 h. NH<sub>3</sub> (60 mL) was added and the mixture was extracted with ether. After evaporation of the solvent the residue was purified by flash-chromatography (eluent: toluene/acetone 4/1) and crystallized by ligroin. This yields 1.1 g of a product with the following characteristics: m.p. 98-100°C; <sup>1</sup>H NMR δ: 2.45-2.65 (m, 8H), 3.35 (s, 2H), 3.52 (s, 2H), 3.85 (s, 3H), 4.85 (s, 2H), 6.95-8.27 (m, 13 H).

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**Example 17. 7-(4-Pyrrolidinobut-2-yn)-oxy-4'-methoxyisoflavone** (see accompanying formula drawing VIB 91)

A solution of formaldehyde (1 ml), pyrrolidine (0.71 g, 0.01 mol) and CuSO<sub>4</sub> (0.2 g) in EtOH/H<sub>2</sub>O (40 mL) was added to a solution of propynyloxy derivative (3.08 g, 0.01 mol) in EtOH/H<sub>2</sub>O (40 mL). H<sub>2</sub>SO<sub>4</sub> was added until pH 8 and the mixture was refluxed 24 h. NH<sub>3</sub> (60 mL) was added and the mixture was extracted with ether. After evaporation of the solvent the residue was purified by flash-chromatography (eluent: toluene/acetone 4/1) and crystallized by ligroin. This yields 0.8 g of a product with the following characteristics: m.p. 111-112°C; <sup>1</sup>H NMR δ: 1.68-1.83 (m, 4H), 2.6-2.65 (m, 4H), 3.5 (m, 2H), 3.85 (s, 3H), 4.83 (m, 2H), 6.96-8.26 (m, 8H).

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**Example 18. 7-(4-Diethylaminobut-2-yn)-oxy-4'-methoxyisoflavone** (see accompanying formula drawing VIB 90)

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A solution of formaldehyde (1 ml), diethylamine (0.73 g, 0.01 mol) and CuSO<sub>4</sub> (0.2 g) in EtOH/H<sub>2</sub>O (40 mL) was added to a solution of propynyloxy derivative (3.08 g, 0.01 mol) in EtOH/H<sub>2</sub>O (40 mL). H<sub>2</sub>SO<sub>4</sub> was added until pH 8 and the mixture was refluxed

24 h.  $\text{NH}_3$  (60 mL) was added and the mixture was extracted with ether. After evaporation of the solvent the residue was purified by flash-chromatography (eluent: toluene/acetone 4/1) and crystallized by ligroin. This yields 1.2 g of a product with the following characteristics: m.p. 73-75°C;  $^1\text{H}$  NMR  $\delta$ : 1 (t, 6H), 2.5 (q, 4H), 3.49 (s, 2H), 3.85 (s, 3H), 4.85 (s, 2H), 6.95-8.28 (m, 8H)

**Example 19. 7-(4-Diethylaminobut-2-yn)-oxyisoflavone (see accompanying formula drawing VIB 92)**

A solution of formaldehyde (1 ml), diethylamine (0.73 g, 0.01 mol) and  $\text{CuSO}_4$  (0.2 g) in  $\text{EtOH}/\text{H}_2\text{O}$  (40 mL) was added to a solution of propynyloxy derivative (2.94 g, 0.01 mol) in  $\text{EtOH}/\text{H}_2\text{O}$  (40 mL).  $\text{H}_2\text{SO}_4$  was added until pH 8 and the mixture was refluxed 24 h.  $\text{NH}_3$  (60 mL) was added and the mixture was extracted with ether. After evaporation of the solvent the residue was purified by flash-chromatography (eluent: toluene/acetone 4/1) and crystallized by ligroin. This yields 0.62 g of a product with the following characteristics: m.p. 79-80°C;  $^1\text{H}$  NMR  $\delta$ : 1.03 (t, 6H), 2.5 (q, 4H), 3.49 (s, 2H), 4.84 (s, 2H), 7.0-8.26 (m, 9H).

**Example 20. 7-(4-Morpholinobut-2-yn)-oxyisoflavone (see accompanying formula drawing VIB 93)**

A solution of formaldehyde (1 ml), morpholine (0.87 g, 0.01 mol) and  $\text{CuSO}_4$  (0.2 g) in  $\text{EtOH}/\text{H}_2\text{O}$  (40 mL) was added to a solution of propynyloxy derivative (2.94 g, 0.01 mol) in  $\text{EtOH}/\text{H}_2\text{O}$  (40 mL).  $\text{H}_2\text{SO}_4$  was added until pH 8 and the mixture was refluxed 24 h.  $\text{NH}_3$  (60 mL) was added and the mixture was extracted with ether. After evaporation of the solvent the residue was purified by flash-chromatography (eluent: toluene/acetone 4/1) and crystallized by ligroin. This yields 1.5 g of a product with the following characteristics: m.p. 104-105°C;  $^1\text{H}$  NMR  $\delta$ : 2.5-2.6 (m, 4H), 3.35 (s, 2H), 3.75 (m, 4H), 4.85 (m, 2H), 6.95-8.22 (m, 9H).

**Example 21. 7-(4-Morpholinobut-2-yn)-oxy-2-methyl-4'-methoxyisoflavone (see accompanying formula drawing VIB 105)**

A solution of formaldehyde (1 ml), morpholine (0.87 g, 0.01 mol) and  $\text{CuSO}_4$  (0.2 g) in  $\text{EtOH}/\text{H}_2\text{O}$  (40 mL) was added to a solution of propynyloxy derivative (3.2 g, 0.01 mol) in  $\text{EtOH}/\text{H}_2\text{O}$  (40 mL).  $\text{H}_2\text{SO}_4$  was added until pH 8 and the mixture was

refluxed 24 h.  $\text{NH}_3$  (60 mL) was added and the mixture was extracted with ether. After evaporation of the solvent the residue was purified by flash-chromatography (eluent: toluene/acetone 4/1) and crystallized by ligroin. This yields 1.2 g of a product with the following characteristics: m.p. 136-139°C;  $^1\text{H}$  NMR  $\delta$ : 2.15 (s, 3H), 2.5-2.6 (m, 4H), 3.35 (s, 2H), 3.7 (m, 4H), 4.7 (m, 2H), 6.95-8.25 (m, 8H).

**Example 22. 7-(4-Morpholinobut-2-yn)-oxy-5-hydroxy-4'-methoxyisoflavone**  
(see accompanying formula drawing VIB 102)

A solution of formaldehyde (1 ml), morpholine (0.87 g, 0.01 mol) and  $\text{CuSO}_4$  (0.2 g) in EtOH/ $\text{H}_2\text{O}$  (40 mL) was added to a solution of propynyloxy derivative (3.2 g, 0.01 mol) in EtOH/ $\text{H}_2\text{O}$  (40 mL).  $\text{H}_2\text{SO}_4$  was added until pH 8 and the mixture was refluxed 24 h.  $\text{NH}_3$  (60 mL) was added and the mixture was extracted with ether. After evaporation of the solvent the residue was purified by flash-chromatography (eluent: toluene/acetone 4/1) and crystallized by ligroin. This yields 0.84 g of a product with the following characteristics: oil, hydrochloric salt m.p. 120-123°C (methanol-ether);  $^1\text{H}$  NMR  $\delta$ : 2.3 (m, 4H), 3.3 (s, 2H), 3.7 (m, 4H), 3.85 (s, 3H), 4.85 (m, 2H), 6.48-7.90 (m, 7H), 12.85 (s, 1H).

**Example 23. 7-(4-Bis-4-Morpholinobut-2-yn)-oxyisoflavone** (see  
accompanying formula drawing VIB 97)

A solution of formaldehyde (1 ml), morpholine (0.87 g, 0.01 mol) and  $\text{CuSO}_4$  (0.2 g) in EtOH/ $\text{H}_2\text{O}$  (40 mL) was added to a solution of propynyloxy derivative (3.2 g, 0.01 mol) in EtOH/ $\text{H}_2\text{O}$  (40 mL).  $\text{H}_2\text{SO}_4$  was added until pH 8 and the mixture was refluxed 24 h.  $\text{NH}_3$  (60 mL) was added and the mixture was extracted with ether. After evaporation of the solvent the residue was purified by flash-chromatography (eluent: toluene/acetone 4/1) and crystallized by ligroin. This yields 1.06 g of a product with the following characteristics: m.p. 158-159°C;  $^1\text{H}$  NMR  $\delta$ : 2.55 (m, 8H), 3.34 (s, 4H), 3.74 (m, 8H), 4.7 (s, 2H), 4.85 (s, 2H), 6.98-8.26 (m, 8H).

**Example 24. 7-(4-Morpholinobut-2-yn)-oxyflavone** (see accompanying  
formula drawing VIB 103)

A solution of formaldehyde (1 ml), morpholine (0.87 g, 0.01 mol) and  $\text{CuSO}_4$  (0.2 g) in EtOH/ $\text{H}_2\text{O}$  (40 mL) was added to a solution of propynyloxy derivative (2.94 g, 0.01

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mol) in EtOH/H<sub>2</sub>O (40 mL). H<sub>2</sub>SO<sub>4</sub> was added until pH 8 and the mixture was refluxed 24 h. NH<sub>3</sub> (60 mL) was added and the mixture was extracted with ether. After evaporation of the solvent the residue was purified by flash-chromatography (eluent: toluene/acetone 4/1) and crystallized by ligroin. This yields 0.75 g of a product with the following characteristics: m.p. 126-127°C; <sup>1</sup>H NMR δ: 2.56 (m, 4H), 3.35 (s, 2H), 3.7 (m, 4H), 4.86 (m, 2H), 6.79-8.2 (m, 9H). Mass: m/z 374 (M<sup>+</sup>, 14.38), 238 (100), 137 (82.79).

**Example 25. 7-(4-Morpholinobut-2-yn)-oxy-3-methylflavone (see accompanying formula drawing VIB 104)**

A solution of formaldehyde (1 ml), morpholine (0.87 g, 0.01 mol) and CuSO<sub>4</sub> (0.2 g) in EtOH/H<sub>2</sub>O (40 mL) was added to a solution of propynyloxy derivative (3.09 g, 0.01 mol) in EtOH/H<sub>2</sub>O (40 mL). H<sub>2</sub>SO<sub>4</sub> was added until pH 8 and the mixture was refluxed 24 h. NH<sub>3</sub> (60 mL) was added and the mixture was extracted with ether. After evaporation of the solvent the residue was purified by flash-chromatography (eluent: toluene/acetone 4/1) and crystallized by ligroin. This yields 0.78 g of a product with the following characteristics: m.p. 139-140°C; <sup>1</sup>H NMR δ: 2.13 (s, 3H), 2.6 (m, 4H), 3.35 (m, 2H), 3.8 (m, 4H), 4.03 (s, 2H), 6.85-8.10 (m, 8H).

**Example 26. 7-(4-Morpholinobut-2-yn)-oxy-4-methylcoumarin (see accompanying formula drawing VIB 95)**

A solution of formaldehyde (1 ml), morpholine (0.87 g, 0.01 mol) and CuSO<sub>4</sub> (0.2 g) in EtOH/H<sub>2</sub>O (40 mL) was added to a solution of propynyloxy derivative (2.14 g, 0.01 mol) in EtOH/H<sub>2</sub>O (40 mL). H<sub>2</sub>SO<sub>4</sub> was added until pH 8 and the mixture was refluxed 24 h. NH<sub>3</sub> (60 mL) was added and the mixture was extracted with ether. After evaporation of the solvent the residue was purified by flash-chromatography (eluent: toluene/acetone 4/1) and crystallized by ligroin. This yields 1.9 g of a product with the following characteristics: m.p. 125-126°C; <sup>1</sup>H NMR δ: 2.4 (s, 3H), 2.52 (m, 4H), 3.3 (m, 2H), 3.7 (m, 4H), 4.78 (m, 2H), 6.16-7.54 (m, 4H).

**Example 27. 7-(4-Diethylaminobut-2-yn)-oxy-4-methylcoumarin (see accompanying formula drawing VIB 94)**

A solution of formaldehyde (1 ml), morpholine (0.73 g, 0.01 mol) and CuSO<sub>4</sub> (0.2 g) in EtOH/H<sub>2</sub>O (40 mL) was added to a solution of propynyloxy derivative (2.14 g, 0.01 mol) in EtOH/H<sub>2</sub>O (40 mL). H<sub>2</sub>SO<sub>4</sub> was added until pH 8 and the mixture was refluxed 24 h. NH<sub>3</sub> (60 mL) was added and the mixture was extracted with ether. After evaporation of the solvent the residue was purified by flash-chromatography (eluent: toluene/acetone 4/1) and crystallized by ligroin. This yields 1.9 g of a product with the following characteristics: m.p. 108-110°C; <sup>1</sup>H NMR δ: 1.04 (t, 6H), 2.42 (s, 2H), 2.5 (q, 4H), 3.7 (m, 2H), 4.8 (m, 2H), 6.18-7.57(m, 4H).

**Example 28. 1-(4-Morpholinobut-2-yn)-oxyxanthone (see accompanying formula drawing VIB 99)**

A solution of formaldehyde (1 ml), morpholine (0.87 g, 0.01 mol) and CuSO<sub>4</sub> (0.2 g) in EtOH/H<sub>2</sub>O (40 mL) was added to a solution of propynyloxy derivative (2.5 g, 0.01 mol) in EtOH/H<sub>2</sub>O (40 mL). H<sub>2</sub>SO<sub>4</sub> was added until pH 8 and the mixture was refluxed 24 h. NH<sub>3</sub> (60 mL) was added and the mixture was extracted with ether. After evaporation of the solvent the residue was purified by flash-chromatography (eluent: toluene/acetone 4/1) and crystallized by ligroin. This yields 1.8 g of a product with the following characteristics: m.p. 98-101°C; <sup>1</sup>H NMR δ: 2.53 (m, 4H), 3.34 (m, 2H), 3.73 (m, 4H), 4.98 (m, 2H), 6.98-8.33 (m, 7H).

**Example 29. 1-(4-Diethylaminobut-2-yn)-oxyxanthone (see accompanying formula drawing VIB 98)**

A solution of formaldehyde (1 ml), diethylamine (0.73 g, 0.01 mol) and CuSO<sub>4</sub> (0.2 g) in EtOH/H<sub>2</sub>O (40 mL) was added to a solution of propynyloxy derivative (2.5 g, 0.01 mol) in EtOH/H<sub>2</sub>O (40 mL). H<sub>2</sub>SO<sub>4</sub> was added until pH 8 and the mixture was refluxed 24 h. NH<sub>3</sub> (60 mL) was added and the mixture was extracted with ether. After evaporation of the solvent the residue was purified by flash-chromatography (eluent: toluene/acetone 4/1) and crystallized by ligroin. This yields 0.64 g of a product with the following characteristics: m.p. 70-72°C; <sup>1</sup>H NMR δ: 1.02 (t, 6H), 2.5 (q, 4H), 3.45 (m, 2H), 4.96 (m, 2H), 6.98-8.33 (m, 7H).

**Example 23. 2-(4-Morpholinobut-2-yn)-oxyxanthone (see accompanying formula drawing VIB 101)**

A solution of formaldehyde (1 ml), morpholine (0.87 g, 0.01 mol) and CuSO<sub>4</sub> (0.2 g) in EtOH/H<sub>2</sub>O (40 mL) was added to a solution of propynyloxy derivative (2.5 g, 0.01 mol) in EtOH/H<sub>2</sub>O (40 mL). H<sub>2</sub>SO<sub>4</sub> was added until pH 8 and the mixture was refluxed 24 h. NH<sub>3</sub> (60 mL) was added and the mixture was extracted with ether. After evaporation of the solvent the residue was purified by flash-chromatography (eluent: toluene/acetone 4/1) and crystallized by ligroin. This yields 1.8 g of a product with the following characteristics: m.p. 105-106°C; <sup>1</sup>H NMR δ: 2.53 (m, 4H), 3.33 (m, 2H), 3.7 (m, 4H), 4.84 (m, 2H), 7.39-7.83 (m, 7H).

**Example 31. 2-(4-Diethylaminobut-2-yn)-oxyxanthone (see accompanying formula drawing VIB 100)**

A solution of formaldehyde (1 ml), diethylamine (0.73 g, 0.01 mol) and CuSO<sub>4</sub> (0.2 g) in EtOH/H<sub>2</sub>O (40 mL) was added to a solution of propynyloxy derivative (2.5 g, 0.01 mol) in EtOH/H<sub>2</sub>O (40 mL). H<sub>2</sub>SO<sub>4</sub> was added until pH 8 and the mixture was refluxed 24 h. NH<sub>3</sub> (60 mL) was added and the mixture was extracted with ether. After evaporation of the solvent the residue was purified by flash-chromatography (eluent: toluene/acetone 4/1) and crystallized by ligroin. This yields 0.64 g of a product with the following characteristics: m.p. 66-68°C; <sup>1</sup>H NMR δ: 1.08 (t, 6H), 2.54 (q, 4H), 3.5 (m, 2H), 4.86 (m, 2H), 7.35-8.38 (m, 7H).

**Example 32. 2-(4-Morpholinobut-2-yn)-oxyxanthone (see accompanying formula drawing VIB 96)**

A solution of formaldehyde (1 ml), morpholine (0.87 g, 0.01 mol) and CuSO<sub>4</sub> (0.2 g) in EtOH/H<sub>2</sub>O (40 mL) was added to a solution of propynyloxy derivative (2.5 g, 0.01 mol) in EtOH/H<sub>2</sub>O (40 mL). H<sub>2</sub>SO<sub>4</sub> was added until pH 8 and the mixture was refluxed 24 h. NH<sub>3</sub> (60 mL) was added and the mixture was extracted with ether. After evaporation of the solvent the residue was purified by flash-chromatography (eluent: toluene/acetone 4/1) and crystallized by ligroin. This yields 1.5 g of a product with the following characteristics: m.p. 126-128°C; <sup>1</sup>H NMR δ: 2.56 (m, 4H), 3.4 (m, 2H), 3.7 (m, 4H), 4.86 (m, 2H), 6.97-8.37 (m, 7H).

**BIOLOGICAL EVALUATION**

Compounds VIB 16, VIB 94, VIB 99 and VIB 100 were tested for their cytotoxicity against drug-resistant cancer cells, both alone, and in combination with paclitaxel.

5 The results of these studies are shown below.

When tested alone these compounds were found to possess relatively low cytotoxicity ( $IC_{50} > 30 \mu M$ ) against drug-resistant cancer cells.

10 The compounds were then evaluated in combination with paclitaxel for their cytostatic activity against the drug-resistant breast cancer cells MDA-435/LCC6-MDR. In the experiments, the compounds were used in combination with paclitaxel, the paclitaxel being at a concentration of  $1 \mu M$ . The  $IC_{50}$  of paclitaxel decreases by 2-4 fold when  
15 compared with paclitaxel alone. Consequently, in the presence of these compounds, paclitaxel can recover its excellent inhibitory activity against the drug-resistant cancer cells.

Compound	$IC_{50}/nM$	% Reduction in $IC_{50}$ of paclitaxel
Paclitaxel	426	-
VIB 16 + Paclitaxel	136	67
VIB 94 + Paclitaxel	210	50
VIB 99 + Paclitaxel	200	53
VIB 100 + Paclitaxel	110	70

Table 1

20

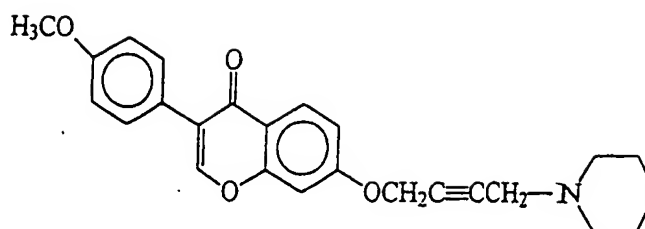
**Experimental**

The treatment consisted of concurrent exposure of MDA-435/LCC-MDR cells to paclitaxel in the presence or absence of the compounds reversing agent ( $1 \mu M$ ) for

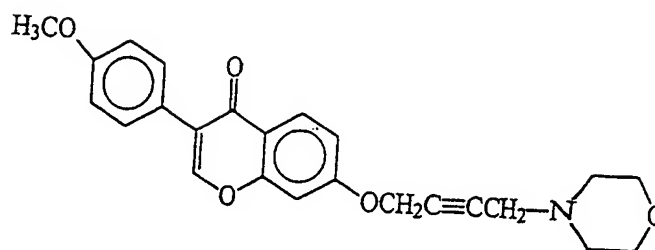
72 h *in vitro*. Assessment of cytotoxicity, i.e. cell growth inhibition, was determined according to the methods of Skehan, et al. as discussed in J. Nat. Cancer Inst., 82, 1107, 1990.

- 5 Briefly, cells were plated between 400 and 1200 cells/well in 96 well plates and incubated at 37°C for 15-18 h prior to drug addition to allow attachment of cells. Compounds were solubilized in 100% DMSO and further diluted in RPMI-1640 containing 10 mM HEPES. After a 72 h incubation, 100 µl of ice-cold 50% TCA was added to each well and incubated for 1 h at 4°C. Plates were then washed 5 times
- 10 with tap water to remove TCA, low-molecular weight metabolites and serum proteins. Sulforhodamine B (SRB) (0.4%, 50 µl) was added to each well. Following a five minute incubation at room temperature, plates were rinsed 5 times with 0.1% acetic acid and air dried. Bound dye was solubilized with 10 mM Tris Base (pH 10.5) for 5 min on a gyratory shaker. Optical density was measured at 570 nm.

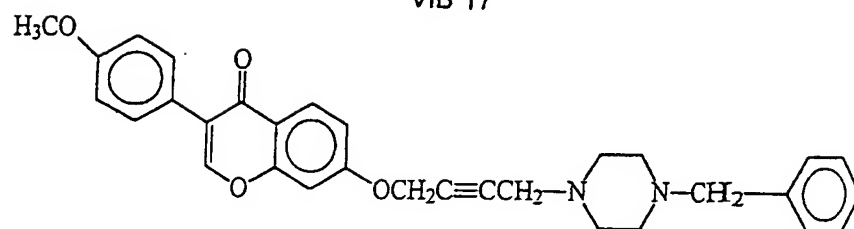
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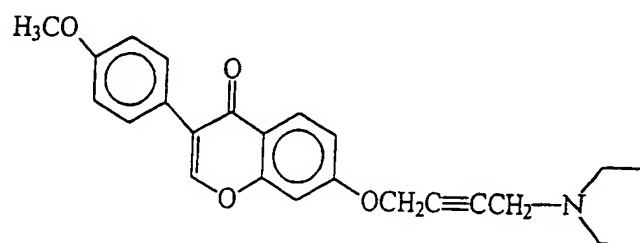
VIB 15



VIB 17

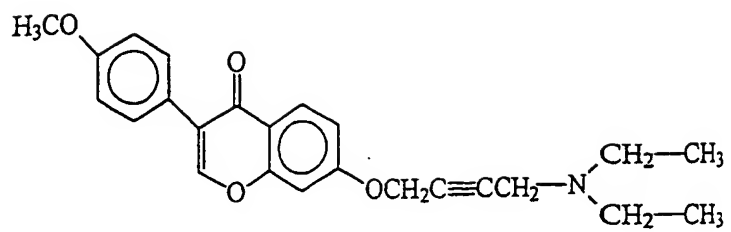


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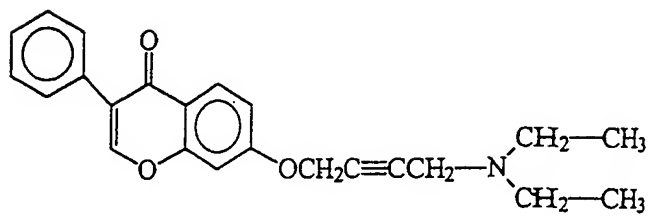


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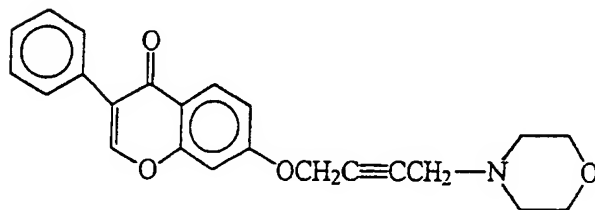
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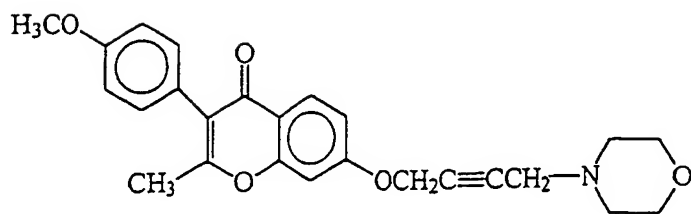
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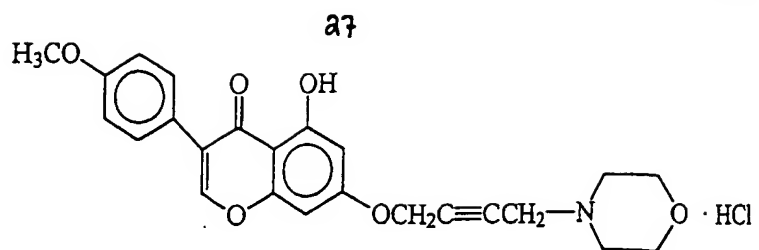
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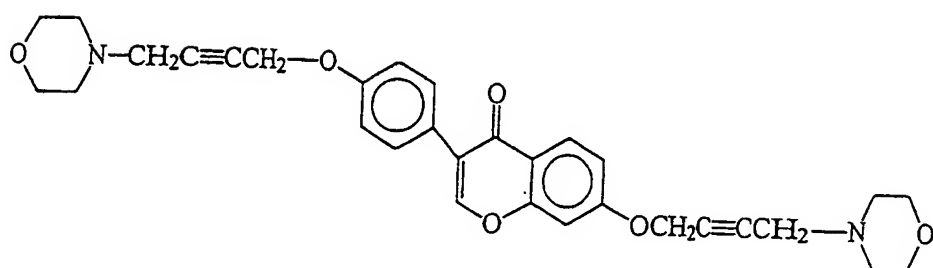
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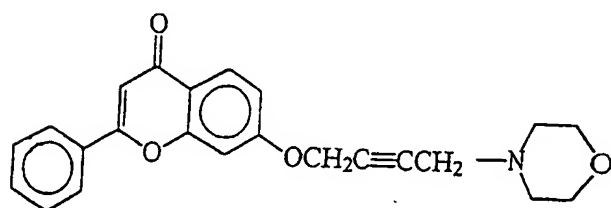
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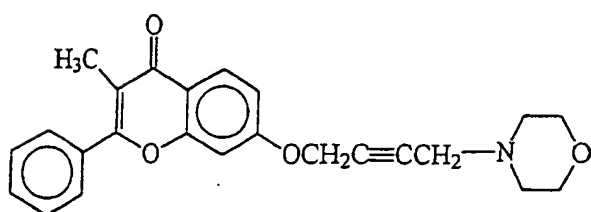
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VIB 97

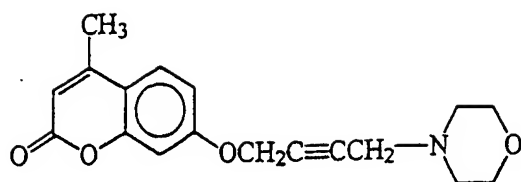


VIB 103

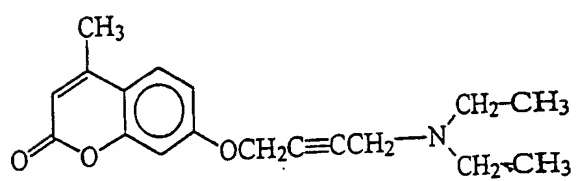


VIB 104

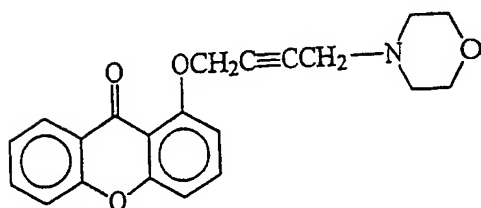
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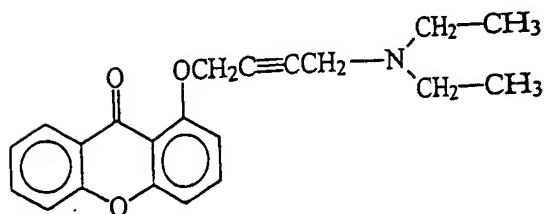
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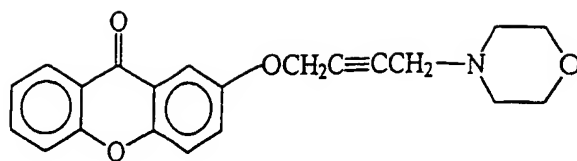
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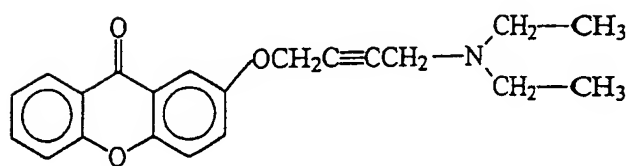
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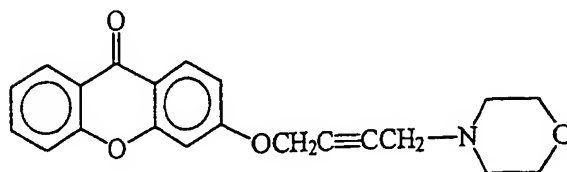
VIB 98



VIB 101



VIB 100



VIB 96

CLAIMS

1. A compound of Formula (I):



(I)

5 or a pharmaceutically acceptable salt or solvate thereof wherein

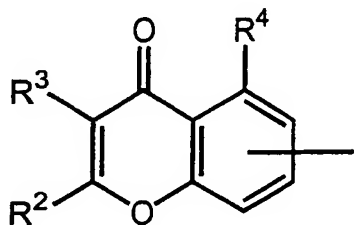
R and R<sup>1</sup> are the same or different and each represents

lower C<sub>1-6</sub> alkyl, or a carbocyclic group containing from 5 to 10 ring atoms,  
said ring atoms forming one or two rings wherein the or each ring contains 5  
or 6 ring atoms, or

10 R and R<sup>1</sup> taken together with the nitrogen atom to which they are attached, form a  
four- to eight-membered heterocyclic ring which may contain one or more additional  
heteroatoms selected from N, O or S, said heterocyclic ring being optionally  
substituted with a lower C<sub>1-4</sub> alkyl group or a benzyl group;

Z represents:

15 (A)



wherein

R<sup>2</sup> and R<sup>3</sup> are each independently selected from:

20 (i) hydrogen, (ii) a substituted or unsubstituted, preferably aromatic,  
carbocyclic or heterocyclic group containing from 5 to 10 ring atoms,  
said ring atoms forming one or two rings, wherein the or each ring  
contains 5 or 6 ring atoms, any heteroatoms being selected from N, O  
and S, any substituents being independently selected from the group  
consisting of:

(a) Cl, (b) Br, (c) F, (d) OH, (e) NO<sub>2</sub>, (f) CF<sub>3</sub>, (g) C<sub>1-4</sub> lower alkyl (in particular CH<sub>3</sub>), (h) SCH<sub>3</sub>, (i) NHCOCH<sub>3</sub>, (j) N(R<sup>6</sup>)(R<sup>8</sup>) wherein R<sup>6</sup> and R<sup>8</sup>, are the same or different and each represents H or lower C<sub>1-4</sub> alkyl, (k) OR<sup>10</sup> wherein R<sup>10</sup> represents H or lower C<sub>1-6</sub> alkyl which may be saturated or unsaturated and being unsubstituted or substituted with the group NRR<sup>1</sup> wherein R and R<sup>1</sup> is as defined above, and (l) OCOR<sup>11</sup> wherein R<sup>11</sup> represents H or lower C<sub>1-4</sub> alkyl,

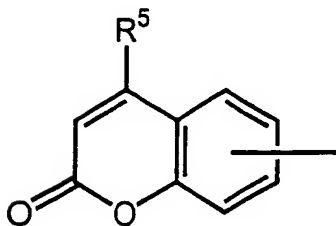
(iii) Cl, (iv) Br, (v) F, (vi) OH, (vii) NO<sub>2</sub>, (viii) a saturated or unsaturated lower C<sub>1-6</sub> straight or branched hydrocarbonyl group which may be unsubstituted or substituted by 1, 2 or 3 substituents selected from Cl, Br, F, OMe, NO<sub>2</sub> and CF<sub>3</sub>, (ix) NHCOCH<sub>3</sub>, (x) N(R<sup>6</sup>)(R<sup>8</sup>), (xi) SR<sup>10</sup>, (xii) OR<sup>10</sup>, and (xiii) OCOR<sup>11</sup> wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are as defined above;

or

R<sub>2</sub> and R<sub>3</sub> taken together with the carbon atoms to which they are attached form a carbocyclic or heterocyclic ring having 5 or 6 ring atoms, any heteroatom being selected from N, O or S, said carbocyclic or heterocyclic ring being saturated or unsaturated, and being unsubstituted or substituted with one or more substituents selected from Cl, Br, F, OH, NO<sub>2</sub>, CF<sub>3</sub>, C<sub>1-4</sub> lower alkyl, SCH<sub>3</sub>, NHCOCH<sub>3</sub>, N(R<sup>6</sup>)(R<sup>8</sup>), OR<sup>10</sup> and OCOR<sup>11</sup> wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are as defined above; and

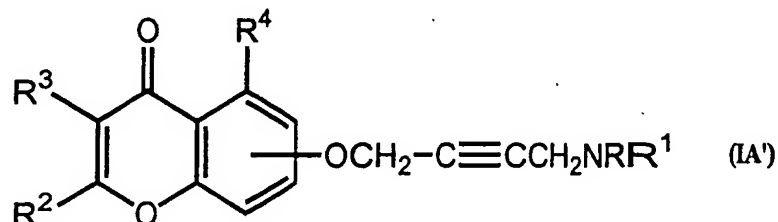
R<sup>4</sup> represents hydrogen, or OR<sup>10</sup> wherein R<sup>10</sup> is as defined above

or  
(B)



wherein  $R^5$  represents hydrogen or a lower  $C_{1-6}$  straight or branched hydrocarbyl group which may be unsubstituted or substituted by 1, 2 or 3 substituents selected from Cl, Br, F, OMe,  $NO_2$  and  $CF_3$ .

- 5      2. A compound of Formula (I) according to Claim 1 having the structure (IA'):



wherein

$R^2$  and  $R^3$  are each independently selected from:

- 10      (i) hydrogen, (ii) a substituted or unsubstituted, preferably aromatic, carbocyclic or heterocyclic group containing from 5 to 10 ring atoms, said ring atoms forming one or two rings, wherein the or each ring contains 5 or 6 ring atoms, any heteroatoms being selected from N, O and S, any substituents being independently selected from the group consisting of:

15      Cl, Br, F, OH,  $NO_2$ ,  $CF_3$ ,  $C_{1-4}$  lower alkyl (in particular  $CH_3$ ),  $SCH_3$ ,  $NHCOCH_3$ ,  $N(R^6)(R^8)$ ,  $OR^{10}$  and  $OCOR^{11}$ , wherein  $R^6$ ,  $R^8$ ,  $R^{10}$  and  $R^{11}$  are the same or different and each represents H or lower  $C_{1-4}$  alkyl,

- 20      (iii) Cl, (iv) Br, (v) F, (vi) OH, (vii)  $NO_2$ , (viii) a saturated or unsaturated lower  $C_{1-6}$  straight or branched hydrocarbyl group which may be unsubstituted or substituted by 1, 2 or 3 substituents selected from Cl, Br, F, OMe,  $NO_2$  and  $CF_3$ , (ix)  $NHCOCH_3$ , (x)  $N(R^6)(R^8)$ , (xi)  $SR^{10}$ , (xii)  $OR^{10}$ , and (xiii)  $OCOR^{11}$  wherein  $R^6$ ,  $R^8$ ,  $R^{10}$  and  $R^{11}$  are as defined above;

or

25       $R_2$  and  $R_3$  taken together with the carbon atoms to which they are attached form a carbocyclic or heterocyclic ring having 5 or 6 ring atoms, any heteroatom being selected from N, O or S, said carbocyclic or heterocyclic ring being saturated or unsaturated, and being unsubstituted or substituted with one or more substituents selected from Cl, Br, F, OH,  $NO_2$ ,  $CF_3$ ,  $C_{1-4}$

lower alkyl, SCH<sub>3</sub>, NHCOCH<sub>3</sub>, N(R<sup>6</sup>)(R<sup>8</sup>), OR<sup>10</sup> and OCOR<sup>11</sup>, wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are as defined above; and

R<sup>4</sup> represents hydrogen, or OR<sup>10</sup> wherein R<sup>10</sup> is as defined above.

- 5 3. A compound according to Claim 2 wherein R, R<sup>1</sup> and R<sup>4</sup> are as defined in Claim 1, and

R<sup>2</sup> and R<sup>3</sup> are each independently selected from:

- 10 (i) hydrogen, (ii) a substituted or unsubstituted, preferably aromatic, carbocyclic or heterocyclic group containing from 5 to 10 ring atoms, said ring atoms forming one or two rings, wherein the or each ring contains 5 or 6 ring atoms, any heteroatoms being selected from N, O and S, any substituents being independently selected from the group consisting of:

- 15 (a) Cl, (b) Br, (c) F, (d) OH, (e) NO<sub>2</sub>, (f) CF<sub>3</sub>, (g) C<sub>1-4</sub> lower alkyl (in particular CH<sub>3</sub>), (h) SCH<sub>3</sub>, (i) NHCOCH<sub>3</sub>, (j) N(R<sup>6</sup>)(R<sup>8</sup>) wherein R<sup>6</sup> and R<sup>8</sup>, are the same or different and each represents H or lower C<sub>1-4</sub> alkyl, (k) OR<sup>10</sup> wherein R<sup>10</sup> represents H or lower C<sub>1-6</sub> alkyl which may be saturated or unsaturated and being unsubstituted or substituted with the group NRR<sup>1</sup> wherein R and R<sup>1</sup> is as defined above, and (l) OCOR<sup>11</sup> wherein R<sup>11</sup> represents H or lower C<sub>1-4</sub> alkyl,

- 20 (iii) Cl, (iv) Br, (v) F, (vi) OH, (vii) NO<sub>2</sub>, (viii) a saturated or unsaturated lower C<sub>1-6</sub> straight or branched hydrocarbonyl group which may be unsubstituted or substituted by 1, 2 or 3 substituents selected from Cl, Br, F, OMe, NO<sub>2</sub> and CF<sub>3</sub>, (ix) NHCOCH<sub>3</sub>, (x) N(R<sup>6</sup>)(R<sup>8</sup>), (xi) SR<sup>10</sup>, (xii) OR<sup>10</sup>, and (xiii) OCOR<sup>11</sup> wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are as defined in Claim 1.

25

4. A compound according to any preceding claim wherein R<sup>2</sup> and R<sup>3</sup> are hydrogen.

- 30 5. A compound according to Claim 1 or Claim 2 wherein one of R<sup>1</sup> or R<sup>2</sup> is hydrogen, and the other is selected from the group consisting of: (i) a substituted or unsubstituted, preferably aromatic, carbocyclic or heterocyclic group containing from 5 to 10 ring atoms, said ring atoms forming one or two rings, wherein the or each

ring contains 5 or 6 ring atoms, any heteroatoms being selected from N, O and S, any substituents being independently selected from the group consisting of:

- Cl, Br, F, OH, NO<sub>2</sub>, CF<sub>3</sub>, C<sub>1-4</sub> lower alkyl (in particular CH<sub>3</sub>), SCH<sub>3</sub>, NHCOCH<sub>3</sub>, N(R<sup>6</sup>)(R<sup>8</sup>), OR<sup>10</sup> and OCOR<sup>11</sup>, wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are the same or different and each represents H or lower C<sub>1-4</sub> alkyl,
- (ii) Cl, (iii) Br, (iv) F, (v) OH, (vi) NO<sub>2</sub>, (vii) a saturated or unsaturated lower C<sub>1-6</sub> straight or branched hydrocarbyl group which may be unsubstituted or substituted by 1, 2 or 3 substituents selected from Cl, Br, F, OMe, NO<sub>2</sub> and CF<sub>3</sub>, (viii) NHCOCH<sub>3</sub>, (ix) N(R<sup>6</sup>)(R<sup>8</sup>), (x) SR<sup>10</sup>, (xi) OR<sup>10</sup>, and (xii) OCOR<sup>11</sup> wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are as defined in Claim 1.

6. A compound according to Claim 4 wherein R<sup>2</sup> is hydrogen and R<sup>3</sup> is selected from the group consisting of: (i) a substituted or unsubstituted, preferably aromatic, carbocyclic or heterocyclic group containing from 5 to 10 ring atoms, said ring atoms forming one or two rings, wherein the or each ring contains 5 or 6 ring atoms, any heteroatoms being selected from N, O and S, any substituents being independently selected from the group consisting of:

- Cl, Br, F, OH, NO<sub>2</sub>, CF<sub>3</sub>, C<sub>1-4</sub> lower alkyl (in particular CH<sub>3</sub>), SCH<sub>3</sub>, NHCOCH<sub>3</sub>, N(R<sup>6</sup>)(R<sup>8</sup>), OR<sup>10</sup> and OCOR<sup>11</sup>, wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are the same or different and each represents H or lower C<sub>1-4</sub> alkyl,
- (ii) Cl, (iii) Br, (iv) F, (v) OH, (vi) NO<sub>2</sub>, (vii) a saturated or unsaturated lower C<sub>1-6</sub> straight or branched hydrocarbyl group which may be unsubstituted or substituted by 1, 2 or 3 substituents selected from Cl, Br, F, OMe, NO<sub>2</sub> and CF<sub>3</sub>, (viii) NHCOCH<sub>3</sub>, (ix) N(R<sup>6</sup>)(R<sup>8</sup>), (x) SR<sup>10</sup>, (xi) OR<sup>10</sup>, and (xii) OCOR<sup>11</sup> wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are as defined in Claim 1.

7. A compound according to Claim 5 wherein R<sup>3</sup> is hydrogen and R<sup>2</sup> is selected from the group consisting of: (i) a substituted or unsubstituted, preferably aromatic, carbocyclic or heterocyclic group containing from 5 to 10 ring atoms, said ring atoms forming one or two rings, wherein the or each ring contains 5 or 6 ring atoms, any heteroatoms being selected from N, O and S, any substituents being independently selected from the group consisting of:

Cl, Br, F, OH, NO<sub>2</sub>, CF<sub>3</sub>, C<sub>1-4</sub> lower alkyl (in particular CH<sub>3</sub>), SCH<sub>3</sub>, NHCOCH<sub>3</sub>, N(R<sup>6</sup>)(R<sup>8</sup>), OR<sup>10</sup> and OCOR<sup>11</sup>, wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are the same or different and each represents H or lower C<sub>1-4</sub> alkyl,

(ii) Cl, (iii) Br, (iv) F, (v) OH, (vi) NO<sub>2</sub>, (vii) a saturated or unsaturated lower C<sub>1-6</sub> straight or branched hydrocarbyl group which may be unsubstituted or substituted by 1, 2 or 3 substituents selected from Cl, Br, F, OMe, NO<sub>2</sub> and CF<sub>3</sub>, (viii) NHCOCH<sub>3</sub>, (ix) N(R<sup>6</sup>)(R<sup>8</sup>), (x) SR<sup>10</sup>, (xi) OR<sup>10</sup>, and (xii) OCOR<sup>11</sup> wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are as defined in Claim 1.

8. A compound according to Claim 5 wherein R<sup>2</sup> represents a substituted or unsubstituted, preferably aromatic, carbocyclic or heterocyclic group containing from 5 to 10 ring atoms, said ring atoms forming one or two rings, wherein the or each ring contains 5 or 6 ring atoms, any heteroatoms being selected from N, O and S, any substituents being independently selected from the group consisting of:

Cl, Br, F, OH, NO<sub>2</sub>, CF<sub>3</sub>, C<sub>1-4</sub> lower alkyl (in particular CH<sub>3</sub>), SCH<sub>3</sub>, NHCOCH<sub>3</sub>, N(R<sup>6</sup>)(R<sup>8</sup>), OR<sup>10</sup> and OCOR<sup>11</sup>, wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are as defined in Claim 1.

9. A compound according to Claim 6 wherein R<sup>3</sup> represents a substituted or unsubstituted, preferably aromatic, carbocyclic or heterocyclic group containing from 5 to 10 ring atoms, said ring atoms forming one or two rings, wherein the or each ring contains 5 or 6 ring atoms, any heteroatoms being selected from N, O and S, any substituents being independently selected from the group consisting of:

Cl, Br, F, OH, NO<sub>2</sub>, CF<sub>3</sub>, C<sub>1-4</sub> lower alkyl (in particular CH<sub>3</sub>), SCH<sub>3</sub>, NHCOCH<sub>3</sub>, N(R<sup>6</sup>)(R<sup>8</sup>), OR<sup>10</sup> and OCOR<sup>11</sup>, wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are as defined in Claim 1.

10. A compound according to Claim 3 wherein R<sup>3</sup> is selected from the group consisting of H, Cl, Br, F, OH, NO<sub>2</sub>, a saturated or unsaturated lower C<sub>1-6</sub> straight or branched hydrocarbyl group which may be unsubstituted or substituted by 1, 2 or 3 substituents selected from

Cl, Br, F, OMe, NO<sub>2</sub> and CF<sub>3</sub>,

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NHCOCH<sub>3</sub>, N(R<sup>6</sup>)(R<sup>8</sup>), SR<sup>10</sup>, OR<sup>10</sup>, and OCOR<sup>11</sup> wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are as defined in Claim 1.

11. A compound according to Claim 3 wherein R<sup>2</sup> is selected from the group consisting of H, Cl, Br, F, OH, NO<sub>2</sub>, a saturated or unsaturated lower C<sub>1-6</sub> straight or branched hydrocarbyl group which may be unsubstituted or substituted by 1, 2 or 3 substituents selected from

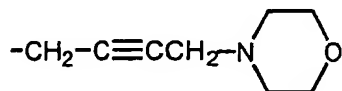
Cl, Br, F, OMe, NO<sub>2</sub> and CF<sub>3</sub>,

- 10 NHCOCH<sub>3</sub>, N(R<sup>6</sup>)(R<sup>8</sup>), SR<sup>10</sup>, OR<sup>10</sup>, and OCOR<sup>11</sup> wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are as defined in Claim 1.

12. A compound according to any of Claims 1 to 9 wherein any substituents on the carbocyclic or heterocyclic group are independently selected from OH or OR<sup>10</sup> wherein R<sup>10</sup> is as defined in Claim 1.

13. A compound according to any of Claims 1 to 9 wherein one of R<sup>2</sup> or R<sup>3</sup> represents phenyl or phenyl substituted with 1 to 3 OH or OR<sup>10</sup> groups.

14. A compound according to Claim 12 or Claim 13 wherein R<sup>10</sup> represents methyl or

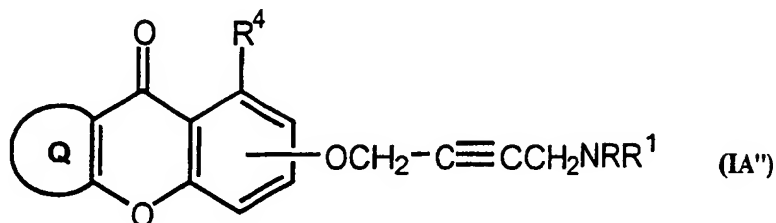


15. A compound according to any of Claims 1 to 11 wherein one of R<sup>2</sup> or R<sup>3</sup> represents H or a lower C<sub>1-6</sub> straight or branched hydrocarbyl group.

16. A compound according to Claim 15 wherein one of R<sup>2</sup> or R<sup>3</sup> represents methyl.

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17. A compound of Formula (IA) according to Claim 2 having the structure (IA''):

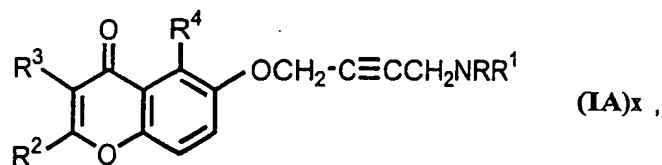


wherein R, R<sup>1</sup> and R<sup>4</sup> are as defined in Claim 1, and R<sup>2</sup> and R<sup>3</sup> taken together represent Ring Q, said Ring Q being a carbocyclic or heterocyclic ring having 5 or 6 ring atoms, any heteroatom being selected from N, O or S, said carbocyclic or heterocyclic ring being saturated or unsaturated and being unsubstituted or substituted with one or more substituents selected from Cl, Br, F, OH, NO<sub>2</sub>, CF<sub>3</sub>, C<sub>1-4</sub> lower alkyl, SCH<sub>3</sub>, NHCOCH<sub>3</sub>, N(R<sup>6</sup>)(R<sup>8</sup>), OR<sup>10</sup> and OCOR<sup>11</sup>, wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are as defined as in Claim 1.

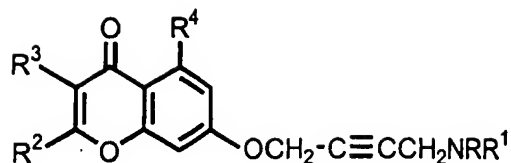
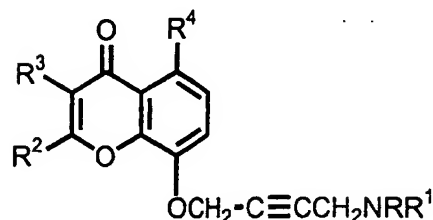
18. A compound according to Claim 17 wherein Ring Q represents a carbocyclic or heterocyclic aromatic ring any heteroatom being selected from N, O or S, said ring being unsubstituted or substituted with one or more substituents selected from Cl, Br, F, OH, NO<sub>2</sub>, CF<sub>3</sub>, C<sub>1-4</sub> lower alkyl, SCH<sub>3</sub>, NHCOCH<sub>3</sub>, N(R<sup>6</sup>)(R<sup>8</sup>), OR<sup>10</sup> and OCOR<sup>11</sup>, wherein R<sup>6</sup>, R<sup>8</sup>, R<sup>10</sup> and R<sup>11</sup> are as defined as in Claim 1.

19. A compound according to Claim 18 wherein Ring Q represents a benzene or pyridine ring.

20. A compound according to any preceding claim having a structure selected from the group consisting of:

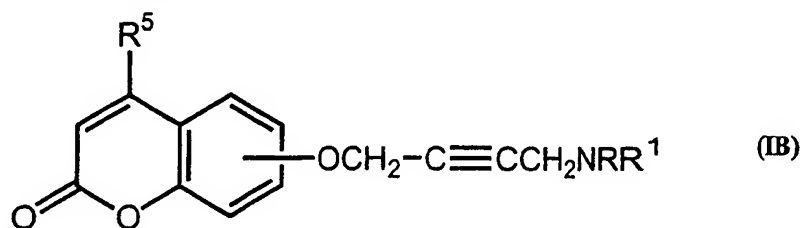


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(IA)<sub>y</sub> , and(IA)<sub>z</sub> .

wherein R, R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup> and R<sup>4</sup> are as defined in any preceding claim.

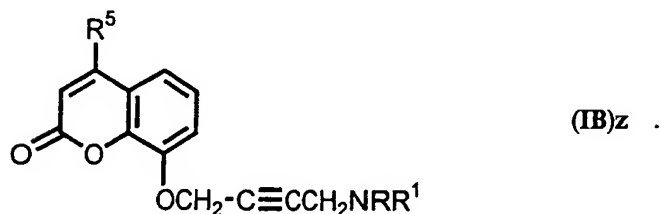
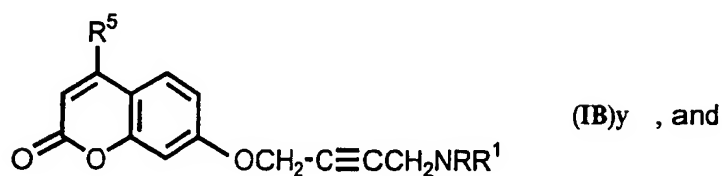
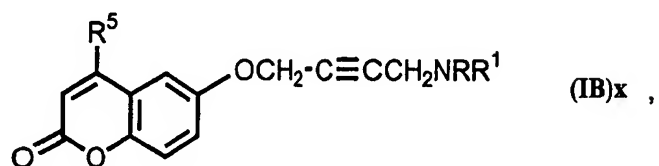
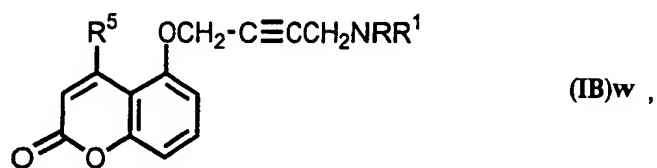
21. A compound according to Claim 20 having the structure (IA)<sub>x</sub>.
22. A compound according to Claim 20 having the structure (IA)<sub>y</sub>.
23. A compound according to Claim 20 having the structure (IA)<sub>z</sub>.
24. A compound according to any preceding claim wherein R<sup>4</sup> represents H, OH or OCH<sub>3</sub>.
25. A compound of Formula (I) according to Claim 1 having the structure (IB):



wherein R and R<sup>1</sup> are as defined in Claim 1 and R<sup>5</sup> represents H or a lower C<sub>1-6</sub> straight or branched hydrocarbonyl group which may be unsubstituted or substituted by 1, 2 or 3 substituents selected from Cl, Br, F, OMe, NO<sub>2</sub> and CF<sub>3</sub>.

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26. A compound according to Claim 25 having a structure selected from the group consisting of:



wherein R, R<sup>1</sup> and R<sup>5</sup> are as defined in any preceding claim.

27. A compound according to Claim 26 having the structure (IB)<sub>w</sub>.

28. A compound according to Claim 26 having the structure (IB)<sub>x</sub>.

29. A compound according to Claim 26 having the structure (IB)<sub>y</sub>.

30. A compound according to Claim 26 having the structure (IB)<sub>z</sub>.

31. A compound according to any of Claims 25 to 30 wherein R<sup>5</sup> represents H or methyl.
32. A compound according to any preceding claim wherein R and R<sup>1</sup> are the same or different and each represents a C<sub>1-4</sub> alkyl group or a C<sub>5-8</sub> cycloalkyl group.
33. A compound according to any preceding claim wherein R and R<sup>1</sup> taken together with the nitrogen atom to which they are attached, form a four- to eight-membered heterocyclic ring.
34. A compound according to Claim 32 wherein R and R<sup>1</sup> are the same or different and each represents methyl, ethyl, propyl, cyclopropyl or a cyclohexyl group.
35. A compound according to Claim 33 wherein R and R<sup>1</sup> taken together with the nitrogen atom to which they are attached form a pyrrolidine, piperidine, N-methylpiperidine, N-benzylpiperidine or morpholine group.
36. A compound according to Claim 1 selected from:
- 7-(4-piperidinobut-2-yn)oxy-4'-methoxyisoflavone (VIB 15),
- 7-(4-morpholinobut-2-yn)oxy-4'-methoxyisoflavone (VIB 17),
- 7-[4-(4-benzylpiperazin-1-yl)but-2-yn]oxy-4'-methoxyisoflavone (VIB 16),
- 7-(4-pyrrolidinobut-2-yn)oxy-4'-methoxyisoflavone (VIB 91),
- 7-(4-diethylaminobut-2-yn)oxy-4'-methoxyisoflavone (VIB 90),
- 7-(4-diethylaminobut-2-yn)oxyisoflavone (VIB 92),
- 7-(4-morpholinobut-2-yn)oxyisoflavone (VIB 93),
- 7-(4-morpholinobut-2-yn)oxy-2-methyl-4'-methoxyisoflavone (VIB 105),
- 7-(4-morpholinobut-2-yn)oxy-5-hydroxy-4'-methoxyisoflavone (VIB 102),
- 7-(4-bis-4-morpholinobut-2-yn)oxyisoflavone (VIB 97),
- 7-(4-morpholinobut-2-yn)oxyflavone (VIB 103),
- 7-(4-morpholinobut-2-yn)oxy-3-methylflavone (VIB 104),
- 7-(4-morpholinobut-2-yn)oxy-4-methylcoumarin (VIB 95),

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- 7-(4-diethylaminobut-2-yn)oxy-4-methylcoumarin (VIB 94),  
1-(4-morpholinobut-2-yn)oxyxanthone (VIB 99),  
1-(4-diethylaminobut-2-yn)oxyxanthone (VIB 98),  
2-(4-morpholinobut-2-yn)oxyxanthone (VIB 101),  
5 2-(4-diethylaminobut-2-yn)oxyxanthone (VIB 100), and  
2-(4-morpholinobut-2-yn)oxyxanthone (VIB 96).

37. A compound of Formula (I) as defined in any preceding claim for use as a  
modulator of multiple drug resistance in cancer chemotherapy or an antiproliferative  
10 medicament.

38. A compound according to Claim 37 wherein the multiple drug resistance is  
mediated by P-glycoprotein.

15 39. Use of a compound of Formula (I) as defined in any preceding claim for the  
manufacture of a medicament for the treatment or prevention of neoplasms.

40. Use according to Claim 39 wherein the neoplasms are located in the uterus,  
ovary or breast.  
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41. Use according to Claim 39 or 40 of a compound of Formula (I) for the  
manufacture of a medicament for the treatment of paclitaxel- and docetaxel-resistant  
cancer cells.

25 42. Use according to any of Claims 39 to 41 of a compound of Formula (I) in the  
manufacture of an antiproliferative medicament for combination therapy.

43. Use according to Claim 42 of a compound of Formula (I) in the manufacture  
of an antiproliferative medicament in combination with one or more antineoplastic or  
30 cytostatic agents.

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44. The use according to Claim 43 wherein the antineoplastic or cytostatic agent is selected from the group consisting of anthracyclines, epipodophyllotoxins, actinomycin D, vinca alkaloids, colchicines, paclitaxel or docetaxel.
- 5 45. The use according to Claim 39 in the manufacture of a medicament for the treatment or prevention of menopausal disorders and osteoporosis.
46. A pharmaceutical composition comprising one of more of the compounds of Formula (I) as defined in any preceding claim, in combination with one or more  
10 pharmaceutically acceptable excipients.
47. A pharmaceutical composition according to Claim 46 further comprising one or more antineoplastic or cytostatic agents.
- 15 48. A pharmaceutical composition according to Claim 47 wherein the antineoplastic agent is selected from paclitaxel or docetaxel.

## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/EP 00/08365

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC 7 C07D311/30 C07D311/36 C07D311/16 C07D311/86 A61K31/37 A61P35/00		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) IPC 7 C07D A61K A61P		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal, CHEM ABS Data, BEILSTEIN Data		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 151 291 A (FRANÇOIS M.J. VALLET) 24 April 1979 (1979-04-24)	1,4,25, 26,29, 31-36 37-48
A	abstract and examples 10-13 the whole document	
A	EP 0 419 132 A (ALLERGAN, INC.) 27 March 1991 (1991-03-27) the whole document	1-48
A	WO 95 18803 A (ALLERGAN, INC.) 13 July 1995 (1995-07-13) the whole document	1-48
A	US 3 513 198 A (JAY PHILIP O'BRIEN) 19 May 1970 (1970-05-19) the whole document	1-48
	-/--	
<input checked="" type="checkbox"/> Further documents are listed in the continuation of box C. <input checked="" type="checkbox"/> Patent family members are listed in annex.		
* Special categories of cited documents : 'A' document defining the general state of the art which is not considered to be of particular relevance 'E' earlier document but published on or after the international filing date 'L' document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) 'O' document referring to an oral disclosure, use, exhibition or other means 'P' document published prior to the international filing date but later than the priority date claimed 'T' later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention 'X' document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone 'Y' document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art '*' document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
6 February 2001		21/02/2001
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016		Authorized officer  Beslier, L

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 00/08365

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>PETROW V. ET AL.: "Analgesics. Part II. Some aryloxyalkyl oxaalkylamines" JOURNAL OF PHARMACY AND PHARMACOLOGY, vol. 10, 1958, pages 86-95, XP000979516 LONDON, GB ISSN: 0022-3573 particularly compound XVa in page 88 -----</p>	1-48

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 00/08365

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4151291 A	24-04-1979	FR 2378519 A DE 2751921 A	25-08-1978 01-06-1978
EP 419132 A	27-03-1991	US 5023341 A AT 127463 T AU 638275 B AU 6261590 A CA 2023811 A CN 1050385 A, B DE 69022152 D DE 69022152 T EG 19293 A ES 2076325 T HK 1008399 A HU 54654 A, B IE 903373 A IL 95475 A JP 3055794 B JP 3167174 A KR 151395 B NZ 235017 A PT 95363 A, B RU 2015969 C US 5053523 A US 5248777 A US 5717094 A ZA 9006840 A	11-06-1991 15-09-1995 24-06-1993 28-03-1991 20-03-1991 03-04-1991 12-10-1995 09-05-1996 30-11-1994 01-11-1995 07-05-1999 28-03-1991 10-04-1991 27-11-1995 26-06-2000 19-07-1991 15-10-1998 25-11-1992 22-05-1991 15-07-1994 01-10-1991 28-09-1993 10-02-1998 26-06-1991
WO 9518803 A	13-07-1995	US 5399561 A AU 684613 B AU 1725695 A CA 2180360 A EP 0738267 A JP 9508104 T	21-03-1995 18-12-1997 01-08-1995 13-07-1995 23-10-1996 19-08-1997
US 3513198 A	19-05-1970	BE 688456 A FR 1500508 A GB 1110378 A NL 6614925 A	19-04-1967 22-01-1968 24-04-1967